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Informal Monthly Progress Letter No. 18

to

AEC-NASA SPACE NUCLEAR PROPULSION OFFICE

for

NERVA PROGRAM

Contract SNP-1

(U)

Letter Report No. L0560-10-18

Covering Period of December 1962

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1. INTRODUCTION

This document is the eighteenth in a series of informal monthly letters reporting progress of the NERVA engine development program and its associated tasks, and is submitted in partial fulfillment of AEC-NASA Contract SNP-1. This document covers the month of December 1962, and is the third monthly report to be submitted during NERVA Contract Year 1963 (1 October 1962 through 30 September 1963).

Work performed in each reporting period is discussed by Task-Item number as defined in the contract. In order to restrict the amount of material presented to a convenient quantity, the intent is to include in each monthly report only that discussion which is required to provide the reader with a concise summary of the work performed. In general, detailed technical information, lengthy theoretical derivations, and extensive data tabulations have been purposely omitted. These details will be provided, as appropriate, in special technical reports.

Program cost information and PERT reports are transmitted under separate cover.

NOTICE

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II. SUMMARY

All participants in the NERVA program continue to devote technical and managerial effort towards the accomplishment of the program goals and objectives defined in REON Report 2322 (C/RD), entitled NERVA Engine Development and Associated Tasks, Contract Year 1963 (U), and published during November 1962. This report reflects the negotiated program plan for Contract Year 1963, and served as a basis for those program modifications necessary to incorporate the Hot-Bleed engine cycle as a development concept. A preliminary draft version of REON Report 2434 (C), entitled Revised NERVA Engine Program and Associated Tasks, Contract Year 1963 (U), was submitted to SNPO-C during this report period. This volume outlined the program revisions necessary to concentrate development efforts upon a Hot-Bleed engine cycle rather than on the Heated-Bleed engine cycle. At a subsequent meeting at SNPO-C representatives of SNPO and REON discussed the contents of the preliminary version of Report 2434, and arrived at general concurrence with the program as defined therein. Development work on the NERVA engine is now being devoted solely to the Hot-Bleed engine cycle.

With the initiation of the Contract Year 1963 effort, the work to be performed under certain Task Items was limited to a 6-month effort, for the purpose of preparation of more complete and definitive program planning details for those Task Items. A new program plan for these task items will be prepared and submitted covering the work to be performed during the remainder of Contract Year 1963. Work on the preparation of this program plan is now in process, and should be virtually completed by the close of the next report period.

Following the review and acceptance of the program changes as outlined in REON Report 2434, and the review and acceptance of the program plan changes to be outlined in the forthcoming publication concerning the final portion of Contract Year 1963, a revision to REON Report 2322 will be published to incorporate all negotiated program changes.

Because of the critical problems associated with providing the Test-Stand Exhaust System for the Engine-Test facilities at NRDS in a time schedule that is compatible with engine test plans, considerable effort has been devoted to the analysis and planning of appropriate actions. This effort culminated in the

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submission of a preliminary draft of REON Report 2433 (S/RD), entitled Preliminary NRDS NERVA Nuclear Rocket Engine Auxiliary Static Test Facility Study (U). The report is currently being reviewed and evaluated by SNPO.

Emphasis has been given to the definition of the Radiation Effects Test Program. This effort was only partially funded during Contract Year 1963 program negotiations, with the understanding that the remainder of the year's efforts would be considered when detailed program plans had been prepared. A revised Radiation Effects Test Program, including a technical discussion, test schedule, and test plans for Contract Year 1963 was prepared and delivered to SNPO-C on 14 December 1962 The document also included five-year radiation effects test schedules. This document is currently being reviewed and evaluated by SNPO-C.

Technical direction and review meetings continue to be conducted with all program participants, following the same procedures as outlined in previous monthly reports. These meetings continue to serve as useful forums for the interchange of technical information and as timely mechanisms for the establishment of action items to expedite the achievement of overall goals and objectives.

During the report period the following reports were transmitted to SNPO:

REON Report Number	Transmitted	Title	Classification
2421	12-1-62	RIFT Safety Review Program, NERVA Systems Description (U)	C/RD
2434	12-3-62	Revised NERVA Engine Program and Associated Tasks, Contract Year 1963 (U)	C/RD
2276	12-6-62	Engine Systems Data Book (U)	C/RD
2466	12-14-62	Revised Radiation Effects Technical Discussion, Test Schedule and Test Plans, Contract Year 1963 (U)	C
L0560-10-17	12-17-62	Informal Monthly Progress Letter No. 17	C/RD
2433	12-28-62	Preliminary NRDS NERVA Nuclear Rocket Engine Auxiliary Static Test Facility Study (U)	S/RD
RN-63003A	12-28-62	Revised NERVA Program Plan for the NERVA Exhaust Sys. for ETS-1 (U)	U
2467	12-29-62	Program Planning Details, NERVA Component Radiation Program, GD/FW	U

REON Report Number	Transmitted	Title	Classification
	12-5-62	Weekly TWX Report No. 7	U
	12-12-62	Weekly TWX Report No. 8	U
	12-19-62	Weekly TWX Report No. 9	U
	12-26-62	Weekly TWX Report No. 10	U

Item 1.1 ENGINE SYSTEM

A. SYSTEM - HOT BLEED

1. Documents

The specification control drawing and design criteria for the adapter and thrust structure were released during this period.

The installation drawing for the upward firing Block I engine has been completed.

The revised planning parts list, layout and assembly drawings and controls schematic for Block I engine have been released. This release completed Milepost 18 for CY 1963.

The specification control drawing and design criteria for NERVA engine interfaces has been initiated.

Release of the Engine Model Specification AGC-10095C has been approved by the customer.

The Engine Systems Data Book was issued during this reporting period. Efforts to fill in the blanks will be started as soon as possible.

A preliminary draft of Specification AGC-10138, Revision A, was completed covering the CFDTS for the Hot-Bleed Engine.

The following NERVA Design Criteria were released:

NDC-50	Line, Supply, ETS-1 Run Tank to Engine
NDC-61	Adapter Assembly, NERVA Engine to Test Stand Thrust Structure, ETS-1

2. Design and Analyses

Work is continuing on the following studies and analyses:

a. Analyses or problems associated with remote assembly and disassembly of the Block I engine.

b. Design study for determination of proper diametral clearances for the major interfaces.

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c. Analyses for determination of the best arrangement for routing the electrical and instrumentation cables and external plumbing across the gimbal.

B. GENERATION II ENGINE SIMULATOR

1. Design and Analysis

A meeting was held at REON with SNPO personnel to review the progress on the analysis of the test data from the Generation II Model I Simulator. Since final data plots were not available at this time, it was agreed that the analysis would continue and the results would be presented at a meeting to be held at Cleveland in January. The detail fabrication drawings for the Generation II Model 1B Simulator were completed and released.

2. Testing

No testing was conducted during this report period.

3. Test Plans

The first issue of the Preliminary "E" Block I Engine Test Plan is now in the process of revision to reflect the Hot-Bleed decision and upgrading as more detail information is made available.

C. DEVELOPMENT TEST SYSTEM

1. Engineering

The design analysis and a proposed configuration of the Cold Flow Development Test System was completed and submitted to SNPO-C (Milepost No. 5). The test objectives, test system schematic, and basic parts list were also included in the above submittal.

Analyses to determine the need for, and objectives of, a Hot Flow Development Test System (HFDTS) were initiated. A conceptual design drawing of the system was completed. The analyses being performed were based on the evaluation of the HFDTS as a non-nuclear, bi-propellant test bed for steady-state testing of the various engine components and subsystems.

D. MOCKUPS

Assembly of the propellant feed system interface has been delayed as the result of fabrication problems. The assembly is expected to be completed early in the next report period.

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Item 1.2 PROPELLANT FEED SYSTEM

A. SYSTEM ANALYSIS

Work continued on the programming and checkout of the digital simulation of the Hot-Bleed engine. The hydrogen properties data subroutine was added to the turbopump subroutine and a check case is being run. The programming of the steady-state models of the nozzle, reactor, and other nuclear components has been completed, and the subroutines are being compiled, and checkout will begin immediately. In the transient model of the nozzle, it was found that a more elaborate representation of the cast material surrounding the nozzle (muff) was not necessary, so the program has been re-written with a single node representation of the muff. A checkout run is now being made. When this is completed, an analysis of the nozzle operation during cool-down will be run.

The hydrogen properties data program mentioned above has been completed, but continues to be refined. Work continued on the writing of a computer program to allow analysis of the problem of laminar-flow instability during cool-down. Information concerning work on laminar instability at Lewis Laboratories and LASL was obtained during trips to these facilities, and will be used in setting up the computer program.

Two new flow schematics of the Hot-Bleed cycle engine were prepared, and will be released soon: one, a parametric flow schematic for the downgraded Hot-Bleed cycle engine, and the other, a flow schematic for operation at 40% power level.

B. PROPELLANT FEED SYSTEM ASSEMBLY

The detail layout drawing for the Propellant Feed System for CFDTS has been released, but design studies are continuing for bellows, remote disconnects, and seals.

Computer programming of the Hot-Bleed engine steady-state analytical model was continued. The analytical model of the gas mixing chamber was developed, and further analysis is being performed on the turbine system equations.

C. VALVES

Design modifications are being made to the E-1 configurations of the TSOV and the TCPV, to improve the remote disassembly capabilities.

Vendor proposals for the electromechanical actuator for the reactor cool-down valve were reviewed, and a vendor was selected to furnish an actuator utilizing 115-volt, 400-cps, 3-phase, ac power. A purchase order was placed for hardware.

Air flow tests of the 3-in. TPCV were conducted and a curve showing predicted flow rate as a function of blade angle has been prepared for the 4-in. configuration from the data obtained.

Test fixtures are being fabricated for life tests of TSOV position indicators, remote actuated disconnect tests of the TSOV, the TSOV seal tester and acceptance tests of the CDV actuator.

The cool-down valve test cell was successfully proof-tested, and the initial test of the Configuration II TSOV seal tester disclosed that modifications are required to prevent secondary seal leakage.

D. TURBOPUMP

Diagnostic disassembly of the Mark II TPA used in the Gen. II Mod 1 simulator tests, combined with data analysis, shows that an impeller rub commenced 50 seconds after FS-1. This malfunction is considered to be a direct result of the reuse of salvaged hardware in building this TPA for use in the simulator.

A turbine stator layout and analytical calculations showing the configuration required to increase power for the E-1 TPA was completed, and fabrication drawings are being prepared.

A TPA pump housing casting successfully completed a burst-pressure test.

The Mark II TPA with turbine interstage instrumentation was tested to 9000-rpm to evaluate turbine-thrust characteristics. A premature shut-down occurred when closure of the TPCV was initiated by a pressure oscillation safety device which had been installed as a precaution for detection of oscillations occurring during a turbopump failure. In this instance, the cut-off oscillations appear, however, to be the result vibrations in the test stand, which was stiffened to eliminate future trouble of this nature. The turbopump was disassembled for inspection and found to be in excellent condition. It is being reassembled for use in the January TPA test program.

The first Mark III (LH_2 cooled power transmission) TPA test was conducted, and all objectives were satisfactorily obtained, the TPA being in satisfactory operating condition following the 50-second run at 5000-6000 rpm. The test had the objective of evaluating any effects of cool-down on initial rotation. Post test inspection was completed and hardware found in excellent condition. Test data are being analyzed.

E. BEARING TESTS

Incremental speed and load tests have been completed on a set of bearings, which included one roller bearing with low profile Armalon cage, and one ball bearing with Armalon cage and molydisulfide coated races. The bearings were in good condition after 30 seconds operation.

The high-speed radiation-effects bearing tester is in the test area for LH_2 checkout prior to final assembly on the RET pallet.

Item 1.3.1 NUCLEAR SUBSYSTEM
REACTOR MECHANICAL DESIGN

A. NRX-A REACTOR

Proof test specifications based on the final detail drawing configurations, have been released for the NRX-A Reactor.

A correlation is planned of reactor vibrations with regard to the power trace during testing, and the uncoupled natural frequencies of the reactor were calculated to determine the instrument ranges required.

Stress analysis was initiated in support of the design review of the Kiwi B-4A/NRX-A reactors. Comparisons of 2, 2-1/4, and 2-1/2 in. core support blocks were made in an effort to define the optimum design.

Bundling loads for the lateral support system were calculated for various force and vibration conditions.

Calculations, which were started to cover dimensional changes of aluminum and titanium pressure vessels relative to the reactor, indicated that the axial coil springs would be adequate to insure seating of the inner reflector against the main seal ring.

A study was begun of a lateral support system which would provide a greater bundling load on the reactor core, and presumably result in improved vibration dampening characteristics for the core.

The bi-linear lateral support spring design has been revised to provide a larger spring cloth area, and calculations were started to determine if a single spring would be adequate.

Test specifications for the investigation of galling and seizing tendencies between the titanium bolts and tapped holes, and detail drawings for the three-row lateral support test hardware, were released this month.

1. Outer Reflector

A study layout was started to investigate the design modifications required for reduction of the ring stresses and deflections.

The NRX-A1 drive shaft will be supported at the actuator instead of at the control drum to ease assembly and disassembly. At disassembly, the drive shaft will remain attached to the test cart.

Flux wires are being added to the outer reflector shim rods to permit mapping of the reactor flux patterns following the completion of the test.

A detail drawing was started to define a new coolant hole pattern to permit installation of thermocouples into fuel elements in an assembled core, including modifications for an improved locking cup. A study layout was initiated to define a simpler means of inserting thermocouples into four instrumented unfueled elements.

The core support plate forging for experimental testing has passed ultrasonic inspection, and material has been removed for mechanical and chemical testing.

A mock-up of the fuel cluster nut locking device has been completed. Tests indicate that approximately 200-in.-lb is required to overcome the deformed locking cup.

A sample extrusion has been successfully made of TaC dispersed in a graphite matrix.

Detail drawings have been initiated for a 2-1/4 inch thick interlocking support block, with an increased bore diameter for the insulating cup, and also for a similar but non-interlocking back-up design. The two designs will be interchangeable for NRX-A1. A study of the irregular (periphery) support block design was initiated to determine whether the reliability of the blocks can be improved.

Study layouts were started for elimination of the thin filler strips at the core periphery, and for reduction of the temperatures and gradients in the larger filler strips.

A short fuel-cluster assembly has been designed to permit testing of a stressed tie rod under irradiation.

A study has been completed, which indicates the feasibility of suppressing the "thermal spike" at the core inlet by attachment of neutron absorbing material to the core-support plate.

2. Inner Reflector

The revised layout of changes to the flow passages in the inner reflector cylinder has been completed, defining the modified inner annulus, which has been changed to limit flow through this path.

A study layout was started of the main core seal configuration as a result of the Kiwi B-4A test.

3. Assembly Stands and Fixtures

Design layouts were initiated for additional assembly equipment which will permit core shimming, re-orificing, and instrumentation operations.

Analysis of all assembly equipment was started, with emphasis on safety requirements of lifting fixtures, and detailed NRX-A assembly procedures were begun.

4. Shipping Containers

Vendor layout drawings for the NRX-A reactor shipping container have been approved, and the vendor is proceeding with detailed design drawings.

Quotations for the design, fabrication, and testing of the revised NRX-A shield shipping container are being evaluated.

Investigations were initiated to determine the modifications which will be required to the current container design concepts to make the design compatible with the severe impact requirements (including a 30-foot drop capability) defined by AEC Regulations.

B. REACTOR SHIELD MECHANICAL DESIGN

That section of the Kiwi B-5 Design Report covering documentation of the design and manufacturing aspects of the shield is complete, and will be incorporated with thermal and nuclear aspects for future issuance.

The specifications and drawings of the NRX-A shield were reviewed; the shield assembly drawings are approximately 90% complete.

Tests are planned to supply shield stress data under specified loading conditions. Data collected from these tests will be correlated with a mathematical model.

A final design on the simulated module has been selected, and one has been fabricated, duplicating module mass, center of gravity, and elastic constants. The simulated modules will be used for structural and vibration studies of the shield.

Initial test results indicated that the screen is of sufficient strength. Further tests were started on screens having a different unsupported diameter (hole size).

C. EVALUATION AND DEVELOPMENT OF REACTOR NON-FUEL MATERIALS

Reported as part of Item 1.9,B.

D. MECHANICAL ANALYSIS AND TESTING

A face thickness of 0.188-in. defines the first phase, and of 0.032-in. on both sides of the support plates defines the second phase, of the structural testing of the cooled-bottom support-plate model. The first phase has been completed, and reduction of the preliminary data indicates that the maximum deflection at the center of the support plate is approximately 0.133-in., when the plate is subjected to a uniform pressure of 3 psi; and that the maximum circumferential strain reading is +5080 micro in./in. Assuming a Young's Modulus of 0.450×10^6 psi, this strain corresponds to a stress of 2260 psi.

An analysis has been performed to determine the axial and radial deflections of the NRX-A inner reflector upper support ring resulting from a 120-psi pressure drop through the core. The axial deflection was calculated to be 0.004 inch, and the increase in the major diameter, 0.009 inch.

A coefficient of static friction of 0.29 for niobium-coated graphite, running on pyrolytic graphite in air, and in hydrogen, was obtained at ambient temperature. The coefficient decreased with increasing temperature, reaching a low value of 0.16 at 3100°R. After cooling to ambient temperature, the coefficient was 0.27.

An approximate S-N curve, plotting stress as a function of the number of cycles-to-failure, was obtained for fatigue of B-1 modules. All tests, upon which the data were based, were run at 20 cps. The modules were vibrated as cantilevers with mass added at the tip in some cases to bring the natural frequency to the proper range. The S-N curve decreases from ~2500 psi at 10^3 cycles to ~1000 psi at 10^6 cycles.

Static tests were run to determine the modulus, and this value, together with readings from a strain gage mounted 1/2-in. from the base, was used to calculate stress.

In the dynamic tests, the strain was set to the desired value. An accelerometer at the tip maintained tip acceleration constant throughout the test. Frequency was held at 20 cps.

E. NRX-B REACTOR MECHANICAL DESIGN

Detail drawings of the hot-flow furnace adapter, including a typical section of a bottom support plate, have been released. The purpose of the test is to simulate the hot and cold gas conditions in and through the base plate, and to evaluate the capability of the plate to withstand these conditions.

A study has been initiated to compare the relative merits of 7-, 12-, and 19-element core clustering with respect to configurations of the transition block and bottom support plate. The two primary criteria involved are the thermal stresses produced in both the transition blocks and the support plate, and the ease of poison wire removal.

Some preliminary calculations were completed on the temperature response of the transition blocks during a reactor startup, and based on this, thermal stress analysis of the blocks was started. A significant improvement in the block stress results when a large number of small passages are used, rather than a few large passages, since the distance from the flow channels to the bulk of the material is reduced. Redesign of the blocks was initiated to incorporate these changes, in addition to provision for poison wire removal and insertion.

The study of poison system concepts relating to bottom core support is continuing, with the objective of achieving a more fail-safe system for combined shipping and in-flight operation. As a parallel approach to the NRX-A poison wire system, transition block designs were revised to enable required quantities of poison wires to be withdrawn and installed through the bottom support plate and nozzle end of the core.

Effort has been extended on adapting a bottom-support plate to a core with a tightly clustered fuel-element configuration. Current considerations entail substituting a sliding, NRX-B core and modifying the NRX-A lateral support system to limit core movement during shock loading.

A vibration analysis has been initiated to compare the two basically different lateral support schemes (felt spaced and tightly clustered elements) under forced vibration. The basis of comparison will be the allowable pressure-vessel acceleration as a function of frequency.

F. E-ENGINE REACTOR MECHANICAL DESIGN

There has been no activity on this project.

G. KIWI B-6 SUPPORT

The nickel 200 sheet material for the shrouds of the B-6 base plates has been released for procurement.

The proposed test program for the Kiwi B-6 series of base plates has been completed. Suggested tests include mechanical loading, pressurization, and both steady and transient thermal-gradient simulation of components, models, and a prototype.

Item 1.3.2 NUCLEAR SUBSYSTEM THERMAL AND FLUID FLOW DESIGN

A. CORE THERMAL DESIGN

Operating temperatures in the cluster plates have been examined to cover usage of tantalum, stainless steel, and aluminum. (Tantalum would be used as a flux suppressor.) Plate temperatures in the center portion of the core are calculated to be below 500°R, but tantalum and stainless steel plate temperatures in some of the irregular plates at the core periphery would be considerably higher.

Two-dimensional heat-transfer calculations were completed for stainless steel and aluminum orifices for local-to-axial maximum peaking factors of 0.5 and 0.7. Stainless steel temperatures were slightly higher and temperature gradients considerably larger, but upper temperatures did not exceed 810°R for aluminum and 1000°R for stainless steel. While it appears that aluminum can be made to work at these peaking factors, stainless steel would be preferable to allow relaxation of temperature limitations during the cooldown period.

Several two-dimensional temperature patterns in the regular fuel-element support blocks have been calculated for different fuel-element outlet temperatures and temperature unbalances within a cluster. These results are being analyzed for thermal stresses.

B. REFLECTOR AND LATERAL SUPPORT THERMAL DESIGN

A detailed study of the temperature distribution of the beryllium outer reflector segments has been completed. Cross sectional isothermal plots at the reflector segment midplane and at the dome end were made using the PAL analog in conjunction with the MCAP computer program.

The temperature distribution in the lateral support blocks was calculated for a nominal concentric clearance of 0.001-in. around the plungers. A parametric study was made to determine the effect of clearance on the graphite surface of the support block contacting the lateral support springs.

A preliminary flow balance of the reflector lateral support system (with only leakage flow in the inner annulus) was made with an inlet hydrogen temperature of 150°R from the nozzle. The pressure drop was maintained at approximately 35 psi. The study showed it necessary to pass considerably more flow

through the annuli at the inner and outer periphery of the beryllium reflector to maintain the 35 psi pressure drop across the reflector.

The thermal analysis of the titanium core support cone was completed. The thermal analysis of the titanium outer reflector support ring was completed, with use of the TOSS conduction program.

C. KIWI B-5 SHIELD THERMAL DESIGN

The Kiwi B-5 shield flow distribution testing has continued. Pressure data tests have been completed and the visual qualitative flow test remains to be completed. The initial set of test results at high pressure indicated considerable random scatter of data. It was necessary to re-run these series of tests after pressure leaks in instrumentation leads were reduced to a minimum and the test method had been reviewed. The second series of tests yielded consistent, reproducible data.

D. NRX-A1 SHIELD THERMAL DESIGN

Transient start-up and shut-down thermal analysis of the shield capsules was initiated.

E. NRX-B COOLED BOTTOM SUPPORT PLATE

Analysis of steady-state temperature distributions in the forged support plate at the tube dome-end plate junction area has been completed. This analysis includes the temperature distribution of the as-designed junction, and the effect of the loss of the pyrolytic graphite from the tube. The results indicate excessively high temperatures would result if the insulating pyrolytic graphite were lost.

The transient startup analyses of a typical section of the forged dome end plate and a section of the support tube were completed, using a one-dimensional heat-transfer model, and the TOSS transient conduction code.

F. THERMAL PERFORMANCE ANALYSIS

A study has been completed of NRX and/or ETS coolant requirements for a full-power run of 20 minutes.

An initial study was completed of cool-down procedures and coolant sequencing following a full-power run.

A 13-channel NRX-A mathematical model was completed for start-up analysis, using the transient analysis code, and a complete start-up analysis is in progress. Additionally, a 7-channel model is being developed to permit more rapid calculations.

A check using the transient code has been made of experimental results of a cold gaseous hydrogen cool-down of a copper tube in the WANL Fluid Flow Laboratory. Temperature response has been found to be in excellent agreement with experimental results. Calculated pressure drop indications were somewhat lower than experimental data, but it is believed that a number of thermocouple beads protruding into the stream increased the pressure drop.

Several perturbation analyses using the digital transient code have been completed for use in development of analog techniques. Cases included step changes in power holding flow and inlet pressure constant. Step changes in flow rate were also examined.

Item 1.3.3 NUCLEAR SUBSYSTEM
NUCLEAR DESIGN AND RADIATION ANALYSIS

A. REACTOR NUCLEAR DESIGN

1. Kiwi B-4A Nuclear Analysis

The experimentally determined fission distributions in the peripheral regions of the Kiwi B-4A and B-4B cores were analyzed, and the results were used to predict coolant channel heat loads in the NTS test of Kiwi B-4A.

2. NRX-A-1 Nuclear Design

The radial power distribution by channel in the NRX-A-1 core was analyzed using a code written for this purpose. The code includes scalloping effects due to control drums, but does not apply corrections for local perturbations due to tie-rod elements or edge irregularities. Element-by-element analysis of NRX-A to include these effects has been deferred pending the re-design of the lateral support and outer core periphery.

Studies were initiated to determine the effects of several methods of improving lateral support on reactivity, power-density gradient at the core edge ("Thermal spike"), and control-drum reactivity span.

Reactivity coefficients for a one-node kinetic model of the NRX-A reactor have been calculated using axial DSN calculations in which the temperature and hydrogen density profiles were accounted for by sub-dividing the core into seven axial regions. These coefficients can be applied during the entire start-up simulation.

3. Methods Development

A test problem for the TDC code was run using four energy groups and three regions. The central region was fueled. The same problem was run using the CURE code in R-Z geometry. The eigenvalues of the two problems agreed to within 1%.

A procedure for the inclusion of Doppler broadening in the calculation of MUFT IV constants has been formulated and is included in the standard design method.

B. SHIELDING AND RADIATION ANALYSIS

1. Kiwi B-5 Shield Analysis

Recent measurements at Los Alamos on the NRX-A shield on the ZEPO assembly show that the initial measurements of neutron and gamma attenuation were too low, due chiefly to room scattering. Analysis of the exact experimental configuration has been started for detailed comparison with the measurements when they become available.

A study was made to determine the radiation level from the NRX shield after exposure in the B-5 test. The results of this study will be used in establishing the procedure for post-operation examination of the shield.

2. NRX Radiation Analysis

Radiation heating analysis of proposed tantalum and silver-cadmium cluster plates indicated maximum values of 580 and 230 watts per cc. Heating rates, fast neutron fluxes, and gamma-energy fluxes in the NRX-A1 pressure vessel have been up-dated.

3. NTS Radiation Analysis

A review was made of shielding design criteria and basis for the E-MAD Hot Cells as reported in Vitro Report KLX 1844. The design criteria were found to be in accordance with current regulations and to be based on the latest radiation sources. The basic shield design for the hot cells appears to be adequate for NERVA components.

The equivalent point source was determined for 1/12 of a Phoebus core arranged in a side-by-side array of modules. This source was used for comparisons with those currently being used for the hot cell design.

4. Methods Development

Development efforts on the Monte Carlo code were concentrated on developing methods for generating thermal neutron cross sections and gamma rays from inelastic neutron scattering.

A program sub-routine was completed for calculation of the mean energy of fissions and fraction of fissions below a given cutoff energy from PlMG output.

C. REACTOR PROOF TESTS

Major efforts continued on building modification, experimental and operational instrumentation, experimental and operational equipment, and hazards safeguards support.

Modifications to the critical facilities are awaiting SNPO approval to proceed.

Review and approval of vendor preliminary control console design was accomplished.

Translation of nuclear design power distribution data requirements to feasible experimental measurements has been completed.

D. REACTOR PHYSICS AND MATHEMATICS

Work continued on the Conditional Monte Carlo transport program. The version of this program using control vanes is in the final stages of debugging. Work also continued on a computer code for reactor transient analysis using a variational method.

The SUMMIT computer code for analyzing slow neutron diffraction in crystals has been used to calculate scattering kernels for beryllium using various crystalline models.

The orifice program is in the final stages of debugging.

Work has begun on a study of the multiple-channel transient heat-transfer program in the hope that considerable improvement can be made in the 7094 running speed.

The DYANA program and its applications are being studied. Input to DYANA consists of a mechanical system of springs, masses, and dampers, and the output is a FORTRAN program which solves the set of differential equations associated with this mechanical system.

Item 1.3.4 NUCLEAR SUBSYSTEM
REACTOR CONTROL SYSTEM DESIGN

Reported under Items 1.5 and 2.4.

Item 1.3.5 NUCLEAR SUBSYSTEM
FUEL-ELEMENT FABRICATION AND PROCESS DEVELOPMENT

A. FUEL-ELEMENT FABRICATION

Difficulties with vapor deposition equipment continue to be a problem. Difficulty has also been encountered in obtaining sufficient coating in the cooling passages.

The vertical graphitization furnace has been redesigned to be usable for vapor deposition and leaching. All required components are on order. This modification will double vapor deposition capacity.

The first shipment of enriched fuel was received from Nuclear Metals Corp. (NUMEC). Full shipments of 40-50 kg each will start in January.

B. FUEL PROCESS DEVELOPMENT AND CONTROL

Five extruded and machined fuel elements were tested at LASL by radiography and eddy current methods. The five showed only one internal indication by eddy current and a number of indications of structural imperfections by radiography.

A program for data processing of inspection information has been initiated. This system will permit storage and recall of all process and inspection data.

A preliminary evaluation of data gathered from experimental graphitizing cycles indicates that a cycle of 9 hr at 1900°C yields the highest composite densities. Samples graphitized in this cycle show densities 0.2% and 0.53% higher than 6- and 3-hr holds at 1900°C.

In conjunction with the experimental graphitizing cycles, data were obtained showing additional shrinkage after heating to 2400°C following graphitizing at 1900°C for various hold times. Samples graphitized for 9 hr at 1900°C and heated to 2400°C yielded an average change in dimension across flats of 0.387%, while length changes were approximately 0.065%.

Final results have been obtained on four fueled batches, as tabulated below, which were made from the basic 85-15 flour thermax blend, and processed through graphitization.

Batch No.	Calculated Loadings, mg/cc		Actual Average Loadings mg/cc	"Carbon" Densities g/cc
	Out of Graphitizing	After Leaching		
193	444	417	447.9	1.776
194	444	417	447.6	1.778
195	444	417	450.8	1.782
196	444	417	451.1	1.778

These batches were loaded with $PyCUC_2$ supplied by Minnesota Mining and Manufacturing Co. (3M). The results were in agreement with all previous batches made with 3M beads concerning final chemistry, loading, and predicted "carbon" density.

Seventeen additional batches of fueled material have been extruded and are at various stages of completion ranging from cure to graphitization. These batches have been loaded with beads supplied by NUMEC, Davison, 3M, and General Atomics.

The fuel particle specification has been revised to include a nitrogen impurity level, a lower oxygen level, and a coating density minimum, and the uranium content and coated particle density have been restricted to values indicated as necessary by developmental processing.

New lots of natural fuel particles have been received from NUMEC and 3M, and density measurements have been made. Measurements of shape, coating thickness, extraneous matter, and uncoated densities remain to be completed. Coating thickness is being determined by micro-radiography, and all old lots are being remeasured by use of this technique.

Runs have been made on samples from group 144 (see page 29, Task 1, previous monthly report) at 1600°C and for various times at 1900°C. On 1/2-in. sample lengths of the 19-hole element, the uranium loss at 1600°C for one hour ranges from 1.54 to 2.56 w/o. A significant amount of the loss is attributed to the exposed element ends.

C. REACTOR COMPONENT FLOW AND CORROSION PROPERTIES

1. Orifice Flow Calibrations

Preliminary tests representative of NERVA-design fuel-element orifices, have been completed. A 5-mil x 45° chamfer on the inlet of a 20-mil orifice was found to cause a decrease in the orifice coefficient from 1.45 to 1.20.

2. Corrosion of Fuel Elements

A low power test has been made with an unfueled graphite element. The power did not exceed 4 kw because of water-supply limitations. A temperature of 775°F was reached.

3. Component Flow Tests

Tests have been started on the tie-rod hanger, tie-rod cluster-plate centering bushing, and tie-rod cone support.

Installation of the compressed air supply has been completed. The first mathematical model using this air supply will measure the loss coefficients of the inlet and outlet beryllium reflector support rings.

The design has been completed of the models to measure the spring chamber leakage and pressure-loss coefficient characteristics of the lateral-support system of the reflector. One model is of a single chamber, while the other model is of a complete segment of nine chambers.

D. EVALUATION AND DEVELOPMENT REACTOR FUEL MATERIAL

1. Physical Property Studies

Thermal expansion measurements on transverse and longitudinal specimens cut from extruded unfueled graphite were extended to 4000°F (~2200°C). Samples of pyrocarbon coated UC_2 were prepared for measurement over the temperature range previously established (-300 to 4000°F).

Equipment to measure thermal conductivity up to 5400°F (~8000°C) has been specified. Equipment is available for measurements up to 4000°F.

2. Mechanical Properties

The first series of room temperature tensile tests on unfueled graphite extruded rods have been completed. A total of 53 tests were conducted, of which 37 were successful. Strain rates of 1×10^{-4}/sec were used. Several modifications of specimen machining and testing techniques have been instituted. The test results are:

ROOM TEMPERATURE TENSILE STRENGTH OF UNFUELED EXTRUDED GRAPHITE

Specimen Type	UTS (psi)	Standard Deviation (psi)	Modulus of Elasticity ($X 10^6$ psi)	Standard Deviation ($X 10^6$ psi)
Longitudinal	3460	340	1.09	0.14
Transverse	2050	550	0.47	0.09
Transverse Web	2320	450		

3. X-Ray Studies

Preliminary data has been obtained on the effect of component concentrations and heat treatment on the preferred orientation of extruded graphite bars. Ratios of the (002) intensities obtained from cuts made perpendicular or parallel to the direction of extrusion were used as an indication of the preferred orientation.

A specimen of 65 flour, 22.5 flake, 12.5 thermax, + binder, baked at 850°C showed the highest preferred orientation, as would be expected, due to the quantity of flake present. It was also noted that the graphitized specimens showed a higher degree of orientation than the baked specimens of the same composition.

4. Hydrogen Corrosion Studies

Preliminary heating tests on unlined, unfueled graphite rods were made to check the power system of the hydrogen corrosion apparatus. Preliminary post-test procedures to evaluate the quality of the test specimens have been established.

5. Reactor Shut-down Corrosion Studies

Apparatus has been assembled to study the effects of nitrogen and air as a function of temperature on fuel, fuel-element liners, and graphite.

6. High Temperature Behavior of Reference Fuel

Samples of as-received pyrocarbon coated UC_2 particles are being examined by electron microprobe and mass-spectrograph techniques. Both techniques have the capability of studying individual particles. Samples of the as-received material were heat-treated in an effort to detect changes which would explain the high temperature migration behavior of the fuel particles.

Item 1.3.6 NUCLEAR SUBSYSTEM
DEVELOPMENT, FABRICATION, AND PROCUREMENT OF PARTS

A. NRX-A REACTOR

Procurement action has been initiated for all significant component parts of NRX-A1 and A2 reactors.

Lithium hydride powder was received and procurement contracts awarded for all remaining capsule materials. Contracts also were awarded for the dome-end head weldment material, nozzle-end head weldment, flange seal, and flow screen. Contracts for tie-plate manufacturing have been awarded. Sample baffle sections were received and are being evaluated.

B. MANUFACTURING ENGINEERING AND SERVICES

The manufacturing development program has been expanded to include brazing, welding, upsetting, and machining techniques, including deep-hole drilling, in coordination with the materials development program. Vendor surveys have been continued.

C. ASSEMBLY, PACKAGING AND SHIPPING

Thirty-six assembly fixtures and stands have been identified as required and are nearing design completion.

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Item 1.3.7 NUCLEAR SUBASSEMBLY DEVELOPMENT TEST PLANNING AND OPERATION

There was no activity on this project.

Item 1.3.8 NUCLEAR SUBSYSTEM TEST PLANNING AND ANALYSIS

The NRX-A Test Program document has been issued. This document outlines specific tests considered for the NRX-A Series Tests.

Preparation continued on a program for a pre- and post-irradiation examination of the Kiwi-B5A Shield. This program describes the tests required to evaluate the shield.

Item 1.3.9 NUCLEAR SUBSYSTEM
REACTOR MODELS AND MOCKUPS

A. MODELS AND MOCKUPS

Orders were placed, and fabrication is in process, for all simulated NRX-A1 reactor components to be used in the instrumentation mockup. Modifications to some of the mocked-up reactor components will be required due to design revision of the top support plate and instrumentation refinements. Mockups of the instrumentation penetrations into the core were completed and assembly problems investigated.

The shield mockup was completed in December.

B. REACTOR ASSEMBLIES FOR NON-NUCLEAR TEST SYSTEM

Preliminary thermal analysis of substitute materials for reflector and shield sections of flow simulators indicated that: a stainless-steel outer tube with stainless-steel tube insert to simulate thermal response of NRX-A shield capsules appears to be satisfactory; and that the aluminum outer reflector and graphite inner reflector behave nearly identically to the thermal response of the NRX-A reflector for low hydrogen flow. Computations based on higher rates of hydrogen flow are underway.

A preliminary layout of the reactor simulator for start-up development has been made.

Item 1.4 THRUST CHAMBER ASSEMBLY (TCA)

A. ASSEMBLY

Revision C of the NERVA TCA Structural Design Criteria Document (No. 9548-62-1) is complete, except for resolution of the differences in pressure factors between the pressure vessel and the nozzle.

Preparation of the TCA Structural Development Program Plan and revision to the NERVA TCA Loads Document (No. 9548-62-16) have been initiated.

Drawings were reviewed for the titanium pressure vessel, the aluminum pressure vessel, and the upper thrust structure.

B. NERVA NOZZLES AND ADAPTERS

1. Heated-Bleed Nozzles

Tubing for the reactor backup nozzles was delivered to Aerojet. Tooling for testing a sample tube bundle with stamped interlocks was fabricated and tubes for fabrication of this bundle were received at Aerojet. Interlocks were brazed to NERVA nozzle Serial 001N, and the nozzle tube bundle was satisfactorily hydrotested.

NRX-A nozzle tube drawings were released and a layout drawing was completed; detail drawings of the NRX-A nozzle are 80% complete, with details of the inlet torus area still to be firmed up. A stress analysis of the NRX-A nozzle was initiated, as was procurement of tubes for four NRX-A nozzles.

2. Hot-Bleed Nozzles

Design of the Hot Bleed nozzle was initiated, using the same basic tube bundle as the NRX-A design. Conceptual designs of the NERVA Hot-Bleed port were made and approved for heat-transfer analysis. The bleed port will be located in the convergent section of the nozzle, as close to the cylindrical section as possible.

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The heat-transfer and hydraulic studies of the Hot-Bleed port are 50% completed.

Procurement of tubing for 6 Hot-Bleed development nozzles was initiated.

3. Adapters for LO_2/LH_2 Simulation Testing

Adapter Serial 001N was cast, and inspection revealed mismatching with respect to the mold, due to a mislocation of the mold pattern. As a result, the thrust support mounting pads are 1/2-inch lower than normal. Either a ring spacer or individual spacers to each leg of the thrust support structure will be required to compensate for this difference.

NERVA adapter Serial 002N was ready for casting. Steps have been taken to preclude the possibility of the mismatch described above.

4. Injectors

Drawing modifications were incorporated to reduce weld warpage and to eliminate the chip removal problems encountered during fabrication of injector Serial 0012. The second, third, and fourth NERVA injectors will conform with these new drawings.

NERVA injector Serial 0112 is approximately 85% complete; all major machining and welding has been completed. The forging for the second NERVA injector will be received on 15 February, to begin machining operations. Forgings for the third and fourth NERVA injectors have been ordered. Injector Serial 1002 PY has been reworked to accept the Kiwi-B thrust support structure. The two first-stage Titan (XLR-87-1) chambers for support of the injector development program have been 75% reworked.

5. Extension

Design analysis was begun on the skirt. The cooling possibilities are being examined with respect to strength and temperature requirements of the skirt, and include cooling methods of liquid hydrogen, turbine exhaust flow, and radiation. All analysis is based on the LO_2-LH_2

simulation for NERVA nozzle conditions. Preliminary results show that liquid hydrogen can be used effectively for the entire skirt in the area between area ratios 10 and 40. This is accomplished with round tubes (double pass), 2 down tubes to 3 up tubes, 0.014-in. wall thickness.

C. THRUST STRUCTURE AND GIMBAL

Revision of the program plan for static testing of the thrust structure has been completed in rough draft.

Fabrication is continuing of the upper and lower thrust structure assemblies (Serials 001 UTS and 001 LTS, respectively). 95% of the material necessary for fabrication has been received.

Design of the upper and lower thrust structure assemblies for the second structural test unit has been started. This design will involve redesign of the pressure vessel, lower thrust structure joint, and a revised gimbal design.

Gimbal redesign is approximately 70% complete.

D. PRESSURE VESSEL

Preparation of the materials report on the A-110AT-ELI titanium plate and the weld-wire evaluation has been initiated. Mechanical test data and chemical and metallurgical data will be presented. Preliminary material design allowables and the weld factor will be established.

Revision A, of the NERVA Titanium Pressure Vessel Development Program Plan (Document No. 9548-62-6) has been published in a preliminary edition.

Design drawings for Serial 002 A aluminum NRX-A pressure vessel have been released for fabrication.

Drawings for the Serial 002 T titanium NRX-A pressure vessel have been completed and are being prepared for release.

Fabrication of the titanium pressure vessel (Serial 001 T) is being held up because of the ring cracking problems which occurred during

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hot sizing of the weld rings. Changes in weld tooling and cleaning procedures have failed to eliminate the problem, which is due to either stress corrosion or stress rupture. A change in the hot sizing cycle is now being made. The forward closure has been completed and the cylinder is ready for welding.

Patterns for the nozzle simulator have been completed and are ready for casting.

A purchase order for six sets of titanium forgings was not placed due to the change in material for pressure vessels requested by SNPO-C.

Tensile testing at room temperature has been initiated of A-110AT-ELI material taken from forgings of Serial 001 T pressure vessel.

The fixtures for the NERVA test tooling are 80% complete.

E. KIWI-B AND HYBRID PROGRAM

Fabrication of Kiwi-B nozzles Serial 001 K and 002 K was completed.

The bolt holes and seal grooves were completed on Nozzle 001K. The inlets were attached and the nozzle was installed in the TCA. The coolant circuit was pressurized at 200-psia proof pressure and 150-psia leak pressure. No evidence of failure was noted, but some seal leakage occurred. The entire TCA was then pressurized to 780 psig, in steps of 100 psi, beginning at 400 psig. Strain gages were attached to the nozzle and adapter so that stress could be monitored to prevent destruction. No damage occurred and the nozzle was removed from the assembly for X-ray and final inspection.

Nozzle 002 K was heat treated and returned to LRP. Final machining was completed, and the nozzle was ready for hydrostatic testing.

F. ROLL CONTROL NOZZLES

Activity in this area of work is scheduled to begin in February 1963.

G. HYBRID NOZZLES

Hybrid nozzle Serial 001 H was returned by the vendor to LRP. This appears to be the best casting obtained to date, although X-ray inspection showed slight gas porosity, with 2 or 3 voids larger than a diameter of 1/16 in. The nozzle was rough machined, the bolt coolant manifold closure was installed, and the assembly was heat treated. Final machining was begun, and the bolt holes were being drilled in the main flange at the conclusion of the report period.

Hybrid nozzle Serial 002 H was laid up on the mandrel, and the core support flange torus, pass-through fittings and support bands were installed. The coolant tubes were completed and were being swaged in preparation for brazing at the end of this report period.

H. ALTERNATE NOZZLE DESIGN

A layout drawing of the U-tube nozzle, extending to the point of 10:1 area ratio, is 75% complete. Detail drawings of the coolant tube (180°-360° configuration) are 50% complete. A study is presently underway to determine if an undivided (no split) tube is feasible. A preliminary heat-transfer analysis of the nozzle-pressure vessel flange has been completed, the results indicating that an internal coolant manifold is necessary. Steel jacket drawings are at vendors for study of the possibility of casting a jacket; a complete heat-transfer analysis of the jacket is already in process. Preliminary tooling drawings have been started for machining of the U-tube slots.

Reviews and recommendations were made on tooling for internally milling the grooves in the U-tube nozzle shell, on fabrication concepts, on brazing alloys, and on methods of fixturing to be used during assembly.

J. HYBRID NOZZLE - ACFI PRESSURE VESSEL HYDRO-TEST

Liaison with LASL and ACFI continued with an increase in follow-up activity on test hardware tooling and procedures. A revision to the test plan was completed.

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All test tooling to be fabricated by Aerojet has been completed. The aluminum pressure vessel, diaphragm, test stand, omega nozzle seals, and nozzle attachments bolts were received from ACFI.

K. APPLIED RESEARCH

1. Pressure-Vessel Materials Test

Reporting on materials research in support of this sub-task is incorporated with other materials efforts under Item 1.9.

2. Liquid-Hydrogen Heat Transfer

The first series of tests at low Reynolds numbers and reverse curvature have been completed and the data is being analyzed. Correlation work is still in progress for all of the data.

3. Gas-Side Heat Transfer

Testing has been completed on the Bleed-Port relocation, and the data is being analyzed. Preliminary data on streaming from the metal bottom support plate was obtained and has been analyzed during this report period. The data indicates that the current nozzle design should not be shortened.

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Item 1.5 ENGINE CONTROLS

A. CONTROLS ANALYSIS

1. Engine System Controls Analysis

a. Power Range Simulation

The analog simulation of the hot-bleed NERVA engine has been used to determine a series of start-up transients by scheduling both reactor power and TPCV position. Measurements were made of the results obtained by changing the system heat capacity, the initial temperatures, and varying power rates. Efforts are being made to update the simulation accuracy by including, in the pressure drop equations, equations describing a variable pressure ratio turbine and a variable Reynolds number. A technical memorandum is being prepared (and will be transmitted to SNPO-C), describing the analog simulation equations in detail and expanding the assumptions which were made.

b. Cool-down

(1) Analog Simulation

The cool-down model for analog-computer simulation has been completely scaled and the computer program boards wired. The functions to represent portions of the convective heat transfer coefficients and pressure drops (which were calculated in digital computer subroutine) have been set into the analog-computer function generators. The complete program is now being checked out on the analog computer.

(2) Digital Cool-down Computations

A matrix program has been adapted to iterate on non-linear coefficients. It solves the same cool-down model as the analog-computer at steady-state conditions. Thus, it is of use in checking out the analog-computer program. Checkout of this program has been proceeding during this period.

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A complex digital-computer program has been written to simulate the transient behavior of the nuclear-rocket engine by means of a detailed cool-down model, and to determine the proper introduction of fluids during cool-down. Equations were developed to rapidly calculate thermodynamic properties as required by the program, for pressures of less than 200 psia, a sufficient region of pressure for cool down. Property equations are being developed for high-speed computation in the high-pressure regions. Checkout of this general program is in progress.

2. Reactor Controls Analysis

a. NRX Controls Analysis

The digital code for transient heat-transfer and flow computation was used to study the incremental transient response characteristics of the NRX-A reactor at various power and flow levels corresponding to the tie-rod cooling constraints. Step changes were introduced at various operating levels in each of the four variables: reactor power, reactor flow rate, pump-discharge pressure, and thrust-chamber pressure. The results of these studies are used to:

(1) Obtain a better picture of inherent reactivity feed-back effects associated with temperature and density changes in the reactor.

(2) Compare inherent reactivity effects for the constant-flow control system now contemplated for NRX-A with the effects resulting from a constant thrust-chamber pressure control as planned for the final engine system.

(3) Develop approximate transfer-function relationships for the reactor at various operating levels.

(4) Improve the current analog simulation models by correlation of their step-response characteristics with those obtained by digital results.

The above step response computations are being carried out with a complete digital representation of the propellant system from the pump discharge to the nozzle exit.

b. Development Engine Reactor Controls Analysis

The bread-board model of the reactor controller was tested in conjunction with the analog-computer model of the reactor to determine its suitability for control. Tests were made of its gain, band-width, and phase margin in the subpower range, with satisfactory results. In the power-range tests, the switching transients (caused when the controller switches from subpower range control to the power range) were found to be small and not difficult. Other power range tests included malfunction simulations to determine the effect on the reactor. Tests of the bread-board controller on the analog-computer are continuing.

An analog simulation of the step-motor actuator for the reactor control drums has been completed and tested.

B. NRX REACTOR CONTROL DESIGN

Work on the NRX-A Control System design is progressing. Contact with vendors has commenced to obtain detailed information on various system components. Standard equipment with demonstrated reliability will be used where possible.

C. ACTUATORS

1. General

The actuator test facility at AGC was redesigned to accept the newer bread-board (NT-B series) TPCV actuator.

The experimental model design (NT-C series) of the TPCV actuator was reviewed by AGC at Bendix.

The assembly of the NT-B3 actuator for the Kiwi-B5 test is continuing. Testing has been done on some of the subassemblies. The torque motor and servo valve were tested at 200°R, and the transmission has had some preliminary tests.

The delivery of the NT-B3 actuator is expected to occur during the latter part of the month of January.

2. Reactor Control Actuators

Due to difficulties with the actuators and other unforeseen problems, insufficient data has been gathered for a decision to be made as scheduled on the drum actuators. The decision as to which electropneumatic actuator to use has been postponed until January 1963.

Cryogenic tests, at 200°R, were started, and run throughout the month.

Testing of the prototype AC servo motor was initiated and is being continued.

Development work in the area of design and test of the DC stepping motor was continued.

D. SYSTEM AMPLIFIERS

Preliminary specifications have been compiled for the temperature control and signal amplifiers and the pressure control and signal amplifiers. The design for these amplifiers has been completed; however, a continuing design effort is anticipated throughout the fabrication phase due to the short delivery schedule.

A radiation test of magnetic amplifiers and semiconductor devices was made at the University of Buffalo reactor. The results of the tests have not yet been published.

E. ENGINE HARNESS

A preliminary draft has been prepared of a report on the current survey of cabling and conductor materials for the engine harness. Preliminary design requirements for the electrical harness were completed and will be incorporated into the electrical harness design criteria, REON's number NDC 26.

F. REACTOR NUCLEAR INSTRUMENTATION

Reported in Item 2.4.

G. PROGRAMMER AND REMOTE ENGINE CONTROL SYSTEM

The preliminary engine-programmer functional diagram has been completed and transmitted to SNPO-C. Design effort is continuing to incorporate current requirements and to establish final functional design. One change in the programmer design is a revised engine start-up operation which is currently being developed at REON in conjunction with WANL.

The functional design of the remote engine control system with its interface to the programmer and the preliminary overall functional diagram of Remote Engine Controls and Engine Programmer are nearing completion.

The panel layout for the Remote Engine Control System Simulator has been completed and the panel is being fabricated. Provisions have been made in the panel design for revisions which may ensue as advances are made in the design of the Remote Control System.

Approximately 90% of the parts required for the panel are either on hand or on order.

Item 1.6 DESTRUCT SYSTEM

A. BASIC FRAGMENTATION RESEARCH

The rate of transmission or attenuation of energy in the core material and/or its simulants is extremely important for an understanding of the fundamental fracture characteristics of this material. Acoustical, mechanical, and explosive techniques for application of different levels of energy are presently being employed in an effort to determine energy attenuation characteristics of the core material, the mechanism of fracture, and the factors which influence break-up.

To facilitate the study of fracture mechanisms, a technique has been evolved for pressure-impregnating fragmented test samples of core material with an epoxy-type resin to permit cutting and polishing as required for microscopic examination.

Such preparation and examination was made of 17 fragment samples, of which 3 were untested control samples. The other fragment samples were selected on the basis of unusual shape or extreme deformation, and were fragments of core material obtained from several different tests. Preliminary examination indicated a marked decrease in number of voids and void volume, and an increased number of microracks.

1. Explosive Fragmentation Experiments

Twelve explosive tests were conducted during the report period.

The previous Monthly Progress Letter described a test in which steel spheres were explosively accelerated to fragment rods of simulated core material contained in a cylindrical volume 10-3/4 in.-dia x 14-1/2-in.-high. A test was conducted this month in which all parameters were repeated, except that the steel spheres were omitted. This test resulted in breaking-up rods contained in a volume 6-1/2-in.-dia x 14-1/2-in.-high. The test using the steel spheres pulverized approximately 55 grams of simulated core material for each gram of explosive, compared with approximately 19 grams in the test without the steel spheres.

Seven tests were conducted to establish a ratio of core material-to-explosive which would produce a desirable range of particle sizes.

In all cases, the explosive was used as a central burster charge. Ratios of 30:1, 60:1, and 100:1 were tested, with the 100:1 ratio most satisfactorily producing the desired fragmentation.

Two tests were conducted to compare the explosive fragmentation of solid circular rods with rods of similar geometry, but containing a hole pattern. These tests indicated that the rods containing the hole pattern were readily able to transmit shock loads and mechanical compression loads, and fractured more easily than the solid rods. The tests also indicated that for an equivalent quantity of explosive energy under similar test conditions, both types of rods experienced a similar hexagonal deformation.

Two tests were made to determine if similar rods with a single large center hole would behave in the same manner as did the rods containing the distributed smaller hole pattern. Hexagonal deformation or deformation into a nearly solid rod did not occur.

2. Mechanical Fragmentation Experiments

A device was fabricated to adopt a drop-weight machine for use in the core simulant mechanical fracture investigations. The function of this equipment is to determine such information as the amount of energy required to fracture or pulverize a core material specimen and the relative effects of across-the-grain and with-the-grain shock loads.

Preliminary tests were conducted on rod elements of simulant core material, 3/4-in. dia x 2-in. long, on which a 400-gram weight was dropped 15-1/4-in. to obtain a single fracture, with a total energy of 1.52×10^7 ergs. At this drop height only 80% of the specimen fractured, the fracture occurring along the grain length.

As part of the investigation of the relationship of core material temperature to resultant fracture, a furnace is being designed to heat specimens for use in the drop-weight tests.

3. Acoustical Energy Experiments

Preliminary investigations were conducted utilizing the intense energy produced by Astrosonic generators in an attempt to measure the attenuation

of sonic energy of various frequencies and amplitudes by the core material. The inability of the laboratory type generators to affect the simulated core material, in addition to the lack of calibration equipment, has not permitted any meaningful results to be obtained thus far.

A vendor has been located with the necessary equipment and capability for doing this work.

B. RADIATION DAMAGE EXPERIMENTS

Tests were continued for the qualification of a capsule design for use in the GETR irradiation experiments. To date none of the designs tested have proven completely adequate to safely contain the detonation of 3.0 grams of explosive, or twice the quantity of explosive which will be used. The largest capsule tested had a diameter of 1-1/2 inches, but newly designed 2-in.-dia capsules are being fabricated for testing.

General Electric Corporation has no established standards for acceptance for such a module and has requested that a Suggested Procedures and Qualification Standard be generated for their approval. This is being prepared.

C. MECHANICAL FEASIBILITY STUDY

A study has been initiated to evaluate the mechanical feasibility of the various candidate explosive destruct system concepts, and to generate preliminary conceptual designs for the integration of these systems with the engine. This study should serve to define the limitations of the contending concepts and should provide a number of basic design parameters which can be used to evaluate the feasibility of any particular concept.

A range of explosive weights was tentatively determined for each of the existing candidate destruct system concepts, based upon limitations of configuration or the need for core insertion.

Some experimental work was undertaken to substantiate analytical and empirical performance predictions by building and testing prototype devices. Two such preliminary tests, in support of the Mark J concept, were conducted to determine the shaped charge parameters and follow-through projectile velocity required. Results of these tests were not conclusive since a faulty explosive

charge prevented proper jet formation in the first test, and a malfunction in the delay train prolonged initiation of the shaped charge in the second test.

D. ANTI-CRITICALITY DESTRUCT EXPERIMENTS

Three anti-criticality destruct system tests were conducted during the report period.

The first test was performed to evaluate the effectiveness of an internally positioned explosive charge. This test was intended to support an internal burster type concept to verify the possible bi-functionality of a Mark D Concept for both anti-criticality and post-operational destruct systems. An available standard 3-in. - 50 projectile containing approximately 1-lb of Octol was placed in a hole drilled in the concrete which filled the Polaris casing. Although the concrete was fairly well fractured, little concrete was forced out of the casing.

In a second test, performed to evaluate the effectiveness of a single shaped charge, an oil well "junk buster" type charge was fired into a confined concrete target. This charge, a cylindrical cavity charge encased in a cast aluminum shell, 7-in.-OD x 8-in.-long, effected a wide but shallow crater in the end surface of the concrete.

The third test involved the use of six conical shaped charges of approximately 80-lb total explosive weight, positioned about the bottom of a steel closure, which effectively simulated the barrier provided by the nozzle material. The direction of the charges was aligned so that the jets produced would intersect within the concrete of the target. Simultaneous initiationof the charges resulted in a splitting of the casing (simulating the engine pressure vessel) and extensive fragmentation of the concrete.

E. POST-OPERATIONAL DESTRUCT EXPERIMENTS

A total of 10 tests were performed during the report period. Five of these were major tests performed against full diameter 1/2-length, or full-scale targets in support of the Mark D or J, F, G, H, and M, Destruct Concepts.* The

*A complete description of the various explosive concepts is tabulated in Table 6.1, REON Report 2421 (C/RD), RIFT Safety Review Program - NERVA Systems Description; also in footnotes, pp. 61, and 65, last monthly progress letter.

remaining 5 tests were explosive charge development tests performed against slab targets.

1. Mk D or J Internal Burster Concept

A test of the Internal Burster Concept (Mark D or J) resulted in a greater degree of fragmentation of the core material than any system previously tested. The simulated core fragments ranged from minute dust particles to pieces 2-in.-long, with a predominate size of about 1/4-in. mesh. The destruct system used in this test consisted of four explosive charges, each weighing 15.8 lb, with one charge placed in each quadrant of the target. The target was a full-diameter, 1/2 length, simulated NERVA reactor. This system will be re-tested and attempts made to determine optimum values of a number of the system parameters.

2. Mk F Concept

A test of the Mark F system against a full-diameter 1/2-length simulated target proved to be fairly ineffective since only a small percentage of fragments within an acceptable size range were produced. The Destruct System configuration consisted of 12 conical-shaped charges having a total explosive weight of 170 lb. Although an increase in the number of charges might increase the system effectiveness, the results of the Mark F system test indicated the number of charges which might be needed to effect the required fragmentation would be so large that the system would present a difficult problem from the standpoint of mechanical feasibility.

3. Mk G Concept

A Mark G destruct system concept was tested against a full-scale simulated reactor using an implosion charge which had more than twice the weight per unit area than the charge employed in the previous test of this concept. The total explosive weight was 655 lb. Almost no dust-size particles were produced in this test. Cursory examination of some of the larger core fragments produced seemed to indicate an increase in the strength over that possessed in their original state.

4. Mk H Concept

The Mark H system was tested against a full-diameter 1/2 length simulated target. The explosive charge consisted of 20 each, 90°-sections of

curvilinear shaped charges, oriented perpendicularly to the core rods. The total explosive weight was approximately 333 lb. The core material breakup was poor, and fragments were generally in the 1/2-in. to 2-in. long range, with a large number of fragments as long as 8 to 9 inches. Charge development tests have indicated that a linear shaped charge capable of putting a jet into the core might weigh several thousand pounds.

5. Mk M Concept

The Mark M destruct concept was tested against a full-diameter partial-length simulated target. This system made use of a single centrally located burster charge containing 15.3-lb of explosive, in conjunction with an implosion charge weighing 123 lb. The average fragment length appeared to be between 1 and 3 inches; however, a considerable number were in the 5 to 7-in. range.

F. EXPLOSIVE PROJECTILE EXPERIMENTS

Five tests were conducted at the Aberdeen Proving Ground in preparation for the full-scale test of the explosive projectile destruct system concept. Previous tests had established the mechanical suitability of a slightly modified M51A5 point detonating fuze, and a 4-1/8-OD seamless mechanical tubing of 1/4-in. thickness was selected for the projectile. Each of the five tests consisted of firing a projectile through a simulated target structure consisting of four feet of plaster board (made up by stacking 1/2-in. sheets of rock lath) fronted with a 1-in. aluminum plate, and backed by a piece of 3-in. armor plate to act as the functioning media for the round.

The propelling charge was established to provide a nominal striking velocity of 700-ft/sec when fired from the 105-mm tank gun M68. High speed photography was used to observe the passage of the projectile through the target and as a means of measuring functioning time upon impact with the 3-in. armor plate. The results of the test showed the fuze functioning time to be in the range of 242 to 288 microseconds, except for one shot which exploded with a "low-order" detonation upon striking the aluminum plate.

The construction of the test butt for recovery of fragmented particles from the 1/4-core section of correct geometry core material was completed 30 October 1962. The fabrication of one full-scale simulated NERVA engine target

for use in the explosive projectile tests at the Aberdeen Proving Ground has been completed and is momentarily awaiting shipment. A second similar target is in the last stages of completion.

Item 1.7 PNEUMATIC SYSTEM

The test objectives for the pneumatic system on the FX engine were defined and integrated into the test plan.

The permissible leakage for the system and for each component was determined. The NERVA design criteria for the various components of the pneumatic system were upgraded by the inclusion of the above, as well as by other recent information.

Design studies based upon the latest NERVA Design Criteria's for the check valves, shut-off valves, filters, regulators, and couplings were initiated.

The Design Criteria for the pneumatic supply tanks has been written, and will be released during the next report period.

The pressure and temperature conditions of the pressurant from the time of initiation of power reduction until the scramming of the reactors were described.

Studies were continued on the check-out, purge, and fill procedures for the pneumatic system.

Item 1.9 RADIATION EFFECTS PROGRAM

A. PROGRAM PLANNING

REON Report 2466, entitled Revised Radiation Effects Program Technical Discussion, Test Schedule, Test Plans for CY 1963 (Conf.) was submitted to SNPO-C on 14 December 1962. This document also included a five year radiation effects test schedule.

A series of meetings were held with General Dynamics/Ft. Worth at Fort Worth during the report period in support of their contract negotiations with SNPO-C, at which time the scope of the ASTR and GTR utilization for CY 1963 was defined. This information is summarized in REON Report 2467 Program Planning Details - General Dynamics/Ft. Worth NERVA Component Radiation Program (Uncl.) issued 29 December 1962.

The revised program and the planning details are currently being reviewed.

B. FACILITIES

Negotiations were started to initiate a sub-contract with Vitro Engineering Company for accomplishing the detailed design of the cryogenic in-pile test loop to be used with REON testing at the Plum Brook Reactor Facility. The cooling system will be designed on the basis of a flow-rate of 0.5 lb/sec of helium at a compressor discharge pressure of approximately 1000 psig. The capsule design will include a vacuum insulating jacket with provision to permit loading from the rear of the capsule.

Work was initiated on preparation of a preliminary hazards evaluation report applicable to PBRF modification design to be issued by WANL.

C. ANALYSIS

The first draft of the Radiation Effects Data Book is being assembled.

An analytical model of the mechanical pallet to be used in the first ASTR test is 50% completed. This model will be used in an analysis utilizing the QAD code.

D. MATERIALS PROGRAMS

1. Engine Materials

In support of the design for the various engine components, work on the current materials programs is continued. These programs include the nozzle braze alloy development, the cast aluminum jacket, the pressure vessel, propellant feed system, gimbal, thrust chamber, and turbopump assemblies.

a. Cast Aluminum Alloy Jacket Material Development

Metallographic examination was completed of aluminum alloy jacketed tube bundles primer-coated with gold, nickel, silver, copper, and eutectic 82% gold-18% nickel. A qualitative analysis of the suitability of these metals and alloy as primers, when employing the "Static-Melt-Consolidation Process," leads to these conclusions:

> Gold reacts metallurgically with A-356 aluminum alloy.
>
> Silver reacts metallurgically with A-356 aluminum alloy; however, it does not appear to form as continuous a bond as does gold.
>
> Nickel does not metallurgically react with A-356 aluminum alloy. This is due to the low solid-solubility of nickel in aluminum when coating without tube preheat.
>
> Copper was found to metallurgically react, but only to a limited extent, with A-356 aluminum alloy.
>
> Eutectic 82%-gold 18%-nickel was found to react, but only to a limited extent, with A-356 aluminum alloy.

On the basis of both the single-tube and the tube-bundle experiments, it appears that gold offers the most promise for primer application. Since the A-356 heat-treatment disrupts the bond between the primer and casting, the use of a self-aging alloy in lieu of A-356 should be considered for the jacket material. Zonzaloy and titanite appear promising in this respect.

The thermal conductance (Btu/hr ft^2-°F) of the bonding primer interface is being determined for gold- and silver-primed tube specimens jacketed with A-356 aluminum alloy. Tests will be conducted on specimens in both the "as-cast" and "T-6" heat-treated conditions.

b. Braze Alloy Development Program

The program includes the formulation of new alloys and the determination of mechanical properties for commercially available braze alloys.

A simulated chamber section using Coast Metals Co. 1700-N braze alloy was cycled at a temperature of 1875°F for 10 minutes. Examination revealed defects and lack of coverage in the tube divider and end casting areas. It has been determined that the 1700-N alloy is extremely sensitive to surface contamination.

Results obtained on the aluminum cast jacket program indicate that a gold primer will be required to effectively bond the aluminum casting and the tubes, requiring a thermal diffusion cycle of 1925°F for approximately 2 hours. This procedure dictates the use of a braze alloy with a minimum solidus of 1950°F to prevent erosion and flow of the alloy during the primer diffusion process. The physical properties of the 1700-N material, which has a solidus of 1670°F, are not compatible with the proposed primer diffusion cycle. The only ductile commercially available braze alloy with a compatible solidus is AGC 44077 (30% Au-25% Ni-25% Pd) which possesses a solidus of 1980°F.

c. Pressure Vessels Materials

This program is being conducted to establish design limitations of the NERVA pressure-vessel material, 5 Al-2.5 Sn-ELI titanium, through testing of materials taken from the pressure vessel forgings. Machining of two hundred tensile specimens, from the forward closure, cylinder, and aft adapter, has been completed, and they will be tested at -420°F, -320°F, -100°F and at room temperatures.

Metallurgical analysis is in progress to determine the cause of failure of test rings during tooling check out at Marquardt-Ogden.

d. Valve and Seal Materials

The thermal characteristics of Inconel X in the double aged condition between -320° and +1600°F have been determined. Results indicate that there is a good agreement with the data published by International Nickel Company, Inc. A laboratory investigation on the hard surfacing of the TPCV body was conducted.

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Inconel X sheet and tubing has been ordered; the sheet material to be used in the preparation of test specimens, and the tubing to be used for checking the coating process with the valve body configuration. Tungsten carbide powder has been ordered.

Examination of test spray coated specimens prepared under the NERVA seal program indicates that changes in powder size and furnace fusion temperature are necessary.

e. Irradiation Effect on Structural Materials

The metallographic and X-ray diffraction examination on the irradiated samples of 304 SS, 347 SS, 17-7 PH, and A-110-AT titanium alloy was completed.

Examination was completed of these materials, scheduled for the next radiation test: 2219, 7079, 7075, 321 SS, and Inconel X.

The microstructures were found typical for these materials in their specified heat-treat or cold-worked condition. Replicates for electron microscopic examination were prepared.

f. Test Specimens and Test Equipment

Design modification and revision on the tensile test equipment for the radiation tests to be performed at Fort Worth were completed.

Stress analysis on the shear-test equipment was performed and order for fabrication placed.

Bids for the thermal-conductivity-test equipment were requested.

Specimens for evaluation of the new sample design of the non-metallic materials were fabricated and scheduled for testing at liquid hydrogen temperature. Fabrication of the metallic specimens for the second radiation run has been ordered.

Shear test specimens have been ordered for alloys.

g. Cryogenic Testing

Tensile tests, using notched specimens made of alloys at liquid hydrogen temperature, were performed. The cryogenic testing of

un-notched specimens of the same materials was delayed due to malfunction of the extensometer.

h. Materials Data Book

Information on design properties for different materials are being compiled and additional graphs prepared, for proposed issuance during the next report period.

2. Reactor Materials

a. Shield Materials

Analytical results on heat treated lithium hydride pellets have shown essentially no change in lithium hydride content when compared to as-pressed material. The effect of heat treatment on the microstructure of these pellets is being studied.

All equipment necessary for the irradiation of the LiH shield capsules is available at GETR. Parametric studies of operating conditions were carried out and charts were prepared to assist in operation at the testing reactor. Irradiation parameters have been re-evaluated in terms of current reactor shield temperature and flux conditions.

b. Reactor Structural Materials

A brazing development study has been initiated on materials for the Kiwi B-6 bottom plate. This study includes such problems as grain boundary penetration, joint ductility at cryogenic temperatures, and dimensional stability of the base material during heating.

c. Control Materials

Installation has been started of the press for hot pressing compacts to produce Al-B control materials. Drawings have been made for the forming and punching dies.

Difficulties have been encountered in attempts to screen two batches of B^{10} powder to separate the usable particle sizes. Measurements indicate the average particle size is approximately 1 to 2 microns, but evidence exists to show that some particles are in the 0.01- to 0.1-micron range. This material cannot be used in its present condition.

Tentative arrangements have been made with LASL to aid in the production of the control plates needed for the NRX-A1 Reactor, using existing raw materials and equipment.

E. TESTING:

A series of irradiation tests on electronic components at the University of Buffalo was completed during December (Tests 21-1, 31-2, and 32-2).

A fuel test was initiated at the GETR (Test 36-1).

A bearing component irradiation test is in progress at the GETR (Test 40-1).

Design concept studies for the Contract Year 1963 mechanical irradiation test pallet systems were initiated.

The design drawings for the electrical irradiation test fixture (Test 29-1) are 80% complete.

Fabrication of the pallet for ASTR Test No. 1 is completed.

Procurement of long-lead spare parts and replacement items for ASTR Test No. 2 was initiated.

Item 2.1 REMOTE HANDLING EQUIPMENT

A. GENERAL

Hot disassembly operations and post-mortem operations were observed at the Nevada Test Site, following the test firing of the Kiwi B4-B reactor. A trip report is being prepared noting operational difficulties, sequences, and times to be utilized in the development of the NERVA assembly/disassembly procedures. Because of the difficulties encountered in this operation, it was decided to disassemble the NRX-A1 core by cutting the inner reflector into sectors, and removing with the core and inner reflector in the horizontal position. A new disassembly procedure was written for this concept, and equipment lists revised.

Development of new design criteria for the Nerva Exhaust System Remote Handling Equipment for a subsonic two-piece duct installation was initiated to evaluate the requirements for hot and cold handling. A proposal (RN-63003A) for NES Remote Handling Equipment was transmitted to SNPO-C on 28 December 1962.

A trip was made to the Los Alamos Scientific Laboratory KIVA 3 area to give technical support to LASL, and to observe activities at that facility during the Kiwi B5-A core assembly. REON personnel participated in actual reactor assembly procedures, thereby gaining valuable information for future assembly - disassembly operations on the NERVA program. A detailed trip report has been written and will be utilized to evaluate NRX assembly procedures.

Evaluation of Provisioning Lists, as submitted by all of the NERVA subcontractors, was continued. These lists are being examined for functional equipment requirements, costs, and schedules. Some of the lists have been returned to subcontractors for clarification, others are being expanded by REON to include missing data. A complete set of NRX and non-nuclear engine Provisioning Lists will be forwarded to SNPO by 30 January 1963.

The WANL Operational Support Plan for the NRX-A1 Reactor was received and review has been initiated. Comments will be submitted to WANL during the next reporting period.

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Major excursion analysis for the E-engine has been initiated to determine the support equipment requirements.

Preliminary End Item Specifications for the Remote Tool Kit, Rocket Engine, were completed.

B. E-MAD FACILITY REVIEW

Vitro drawings of the E-MAD Facility Phase II post-mortem cell were reviewed for information which might affect equipment parameters. Additional E-MAD Phase II work undertaken during this period included the compilation of loading requirements for the Metal Parts Warm Cell, which was transmitted to SNPO in the Addendum to Report 2325.

A study has been performed of the effects upon support equipment of utilizing the ETS-1B test stand for an upward firing engine test. Two different techniques of handling the engine within the E-MAD building, and during transport to and from ETS-1B were presented to SNPO-C in REON Report 2433. This report also included a discussion of the effects on support equipment should Test Cell A be used in lieu of ETS-1B.

C. REMOTE HANDLING SUBYSTEMS

Assembly drawings and schedules of the Engine Installation Vehicle (EIV) Overhead Positioning Subsystem (OPS), Manned Control Car (MCC), and Floor Mounted Handling Subsystem (FMHS), are being prepared for transmittal to SNPO-C by 10 January 1963.

The EIV, MCC, OPS, and FMHS detail designs are continuing and preliminary design recommendations are being integrated.

1. Overhead Positioning Subsystem

A malfunction analysis has been initiated on the OPS.

2. Wall-Mounted Handling Subsystem

A review was completed of proposals from General Electric, American Machine and Foundry, and General Mills for Wall Mounted Handling Subsystem. The evaluation included comparison with Vitro Purchase Specification 1425-PS-4 and

a technical appraisal of the proposals. Three basic and four alternate proposals were evaluated, including the preparation of composite sketches and 25 sheets of comparison tables. The following documents, incorporating the comments and recommendations of REON, were prepared and presented to SNPO-C at Cleveland, on 19 December 1962: Critical WMHS Parameters, Technical Evaluation of Proposals for Wall Mounted Handling Subsystem, Proposed Reductions in Specification Requirements.

D. VEHICLES

1. Manned Control Car

The MCC cab design has been revised to reduce the weight of the MCC in an effort to provide a greater margin of tractive power for the 80-ton locomotive being supplied by SNPO. PERT diagrams and a program plan are being prepared, in accordance with the negotiated contract.

2. Remote Bulldozer

The Remote Bulldozer Specification is being upgraded.

3. Test Cars

WANL completed a detail design of the support stand for the test cars and forwarded it to ACFI.

Approval for material order of test car long lead components for 3 test cars was given to ACFI based on their present design and WANL modifications.

Reactor/Vessel and test car assembly drawings were started.

Studies continued of radiation heating in test car components and reactor external instrumentation.

Item 2.2 GROUND SUPPORT EQUIPMENT CHECKOUT AND TEST SYSTEMS

A system analysis was completed of the Wall Mounted Handling Subsystem electrical and control system as proposed by American Machine and Foundry, General Electric, and General Mills, and transmitted to SNPO-C, on 19 December 1962.

An ROM estimate and technical discussion was prepared covering electrical power, control, and interface equipment required for inverting the engine at ETS-1B by two different methods, as discussed in Report 2433. One method involved additional equipment additions to the Engine Installation Vehicle, the second method involved a separate test car to transport the engine and a trunnion stand to turn the engine over in the E-MAD building. The estimates included interfacing with checkout, test, and simulator stations as required.

An analysis of AMF electrical data submitted at the Technical Direction Meetings of 14 and 15 December 1962, was continued. A master diagram of all AMF furnished electrical and control equipment was started. This is preparatory to starting an E-MAD elementary single line electrical diagram in January, which will define Vitro-AMF interfaces, establish power distribution levels, electrical service entrance, and load center requirements as applied to support equipment requirements, so that any construction and installation difficulties may be anticipated and avoided by proper liaison and management.

A detailed sub-task program plan for checkout and test equipment was prepared. This plan illustrates the procedures to be followed, such as design criteria, specifications, design schedules, etc., for meeting the test firing date, and insuring more compatible checkout and test support equipment. Schedules for initiation of design criteria to completion of delivery and checkout were chronologically illustrated and will be utilized as a guide to functions of this task item.

A list of checkout requirements for the NRX-A Reactor and the E-Engine is being prepared for use with the support-equipment provisioning lists, operational-support plan, and the program flow chart. This list will aid in planning the equipment required to support the NERVA program.

A meeting was held with WANL to discuss pertinent checkout and test requirements and the following comments were noted:

A. The Engine Simulator was again defined as a unit of checkout as opposed to a design tool. As such, it shall contain devices necessary to supply the necessary response as determined by the engine/reactor system. WANL will supply information on the nuclear portion of the engine as availability permits, for use in determining Engine Simulator requirements.

B. The Checkout and Test Section will supply size and configuration requirements for the Engine Control Console Panel after review of the Dreyfuss study on the Control Point Room layout.

C. WANL will supply appropriate panels for the breadboard Engine Control Console presently under design.

D. Dreyfuss will fabricate a full scale cardboard model of the Control Point test consoles for evaluation by cognizant parties.

E. Copies of preliminary engine control designs were received, and will be used to determine detailed checkout and test equipment criteria.

Item 2.3 GROUND SUPPORT EQUIPMENT
TRANSPORT, GROUND HANDLING, AND MAINTENANCE

A detailed Program Plan for Item 2.3 operations during Contract Year 1963 has been prepared. This plan includes specific task and sub-task requirements to be accomplished during the contract year, and incorporates all NERVA subcontractor responsibilities and costs and will be utilized as a guide to the functions of this task item.

An evaluation of Support Equipment Provisioning Lists is continuing. This study was undertaken to determine the adequacy of subcontractor equipment requirements and schedules. Where information was found to be incomplete or missing, the Provisioning Lists will be upgraded or otherwise completed respective to their Provisioning List Sets.

The following End Item Specifications were completed:

1. Adaptor, Lower Thrust Structure
2. Support Ring, Upper Thrust Structure
3. Support Ring, Pressure Vessel
4. Container, Nozzle
5. Manual Tool Kit, Turbopump
6. Manual Tool Kit, Rocket Engine
7. Slings

Detail design of the following end items was started:

1. Sling, Multiple Use
2. Sling, Upper Thrust Structure
3. Strongback, Multiple Use
4. Stand, Upper Thrust Structure
5. Stand, Lower Thrust Structure
6. Support Ring, Pressure Vessel

7. Support Ring, Upper Thrust Structure

The Dump Car specification activity has been deferred temporarily because of required review of the NRX and CFDTS documents to meet contractual milestones.

Review was conducted on 19 WANL handling equipment design drawings for use at WANL - Large and Waltz Mills facilities in plant. Approval for the purchase of this equipment was transmitted to WANL on 3 January 1963.

Item 2.4 INSTRUMENTATION

A. INSTRUMENTATION DATA BOOK

Work continued in the writing and assembly of the various sections of the Instrumentation Data Book. A preliminary edition of the Instrumentation Data Book was published in October 1962, with revisions in December, and the first issue will be published during January 1963.

B. NRX-A INSTRUMENTATION

A meeting was held at WANL to discuss and resolve NRX-A-1 instrumentation problems. As a result, an upgraded and definite version of the NRX-A-1 parameters list was issued.

Selections were made and requisitions written for instrumentation components for the NRX-A-1 pressure vessel and nozzle.

Preliminary instrumentation schematics were prepared to illustrate transducer locations on the NRX-A-1 pressure vessel and nozzle.

Completion of NRX-A-1 installation design is anticipated for January.

Four connector layouts were made to facilitate handling and to gain experience with connector problem peculiar to radiation environments. Three connectors now in test in the Western New York Facility are expected to supply needed information on pin-to-pin insulation resistance for NRX-A-1 connectors.

C. MECHANICAL COMPONENT IRRADIATION TEST INSTRUMENTATION

Transducers for the Mechanical Component Irradiation Test No. 2 were selected.

Specifications were generated for additions to the GD/FW Radiation Effects Facility Instrumentation System.

D. CRYOGENIC TEMPERATURE TRANSDUCER DEVELOPMENT

Three silicon semi-conductor resistance thermometers were received. These units were developed under sub-contract with Electro Optical Systems, Inc. of Pasadena, California.

The cryogenic temperature measuring system used on the Gen II, Mod 1 tests was recalibrated, and the data analyzed. No discrepancies were found.

E. THRUST CHAMBER TEMPERATURE TRANSDUCER DEVELOPMENT

Delivery of tungsten resistance thermometers ordered from Rosemount Eng. Co. and Electrowest has been delayed. Other vendors have been contacted concerning development of thrust-chamber temperature transducers.

F. THRUST CHAMBER PRESSURE TRANSDUCER DEVELOPMENT

Design of three water-cooled manifolds capable of accommodating 8 transducers each for irradiation testing was completed.

A new transducer development by Giannini indicated that this company should be included with Edcliff Instruments and Servonic Instruments for design and fabrication of radiation-resistant potentiometer-type, pressure transducers for chamber-irradiation pressure transducers.

G. REACTOR NUCLEAR INSTRUMENTATION DEVELOPMENT

1. Nuclear Detector Development

A gamma-compensated ionization chamber has been completed. During the present series of irradiation experiments at the Western New York Nuclear Research Center in Buffalo, New York, this chamber will be tested to determine gamma response and compensation characteristics. No high flux radiation is being used for these tests.

Two development model fission counters, recently designed and fabricated at WANL, are also being tested in Buffalo for response and gamma discrimination.

2. Nuclear Instrumentation

Radiation testing of a chopper-stabilized log microammeter preamplifier circuit, coaxial cables, electronic circuit boards, and electrical connectors was conducted.

Breadboard work on high-counting-rate circuitry has continued with successful operation of Cook Yarborough circuitry to 500,000 counts per second. Accuracy so far has not been satisfactory. Work continued on this and conventional log pulse integrating circuitry.

Preliminary breadboard circuits have been built and tested to determine the best design approach for power range log microammeter (long cable) development.

3. Radiation Effects Testing

Preliminary results were obtained for experiments 6 through 10, conducted at the Western New York Nuclear Research Center Reactor. These experiments involved radiation effects tests on coaxial cables, electronic tubes, electrical insulating coatings, DC preamplifier stages, and a pulse preamplifier.

H. TRANSDUCER EVALUATION PROGRAM

A detailed test specification for Electrical Irradiation Test No. 1 was completed and revised.

The position transducers for Test No. 2 were selected, and the initial draft of this test was completed.

Fabrication drawings for test fixtures required in Test No. 1 are 80% complete.

Six turbine speed sensors were received from Electrowest, Inc. Acceptance testing is planned for January.

Test jigs have been completed and calibrated for reactor testing of strain gages and resistance thermometers in LN_2 at the GTR in Fort Worth.

Development continued of a "shaker" table for vibration testing accelerometers at liquid nitrogen temperatures for GTR tests.

I. BENDIX SUBCONTRACT

A meeting was held at Azusa on 19 December 1962, with Bendix representatives who submitted three reports:

1. Cooling and Heating Analysis of Pressure and Vibration Transducers Between the NERVA Shield and Gimbal, Bendix Report No. 2243 (U).

2. Recommended Displacement Transducers for the NERVA Environment, Bendix Report No. 2259 (C/RD).

3. Recommended Temperature Transducers for the NERVA Environment, Bendix Report No. 2260 (U).

Copies of these reports have been delivered to SMPO.

Bendix will continue to make analysis and issue reports on other MERVA instrumentation problems as directed.

Item 2.5 FIELD SUPPORT (RIFT)

The third meeting of the NERVA/RIFT Interface Working Group was held at Lockheed on 6 and 7 December, with full committee attendance. The areas of consideration and personnel assignments of the various task groups were reviewed and approved. A proposed outline for the Interface Agreement was made available for further work at the Task Group level. The next meeting of the group is scheduled for 12-13 February 1963, at Aerojet's Liquid Rocket Plant, Sacramento.

Directive Number 1 of the NERVA/RIFT Interface Committee was made available early in December. In general, this document formalized and approved various procedures and organizational responsibilities which had been discussed at the working group level and submitted to the Interface Committee for approval. Fifty-three ground rules covering both general and particular interface areas were established for the guidance of the Working and Task groups.

Task Group effort continued, with the objective of providing by 1 February 1963, a draft of a documented statement (as a minimum) on each heading and subheading of the Recommended Areas of Consideration for the NERVA/RIFT Task Groups. These drafts will be reviewed at the February Working Group Meeting.

General engineering liaison was maintained throughout the report period.

Item 2.6 RELIABILITY AND QUALITY CONTROL

REON, LRP, WANL, AMF, and Bendix have initiated program plans and cost estimates for the work to be conducted as part of Item 2.6 during the period between 1 April and 30 September 1963. This activity will be continued as a major effort in the month of January 1963.

The design review of the advanced NERVA nozzle was completed, and a memorandum report of the recommendations was prepared.

A failure-mode analysis was initiated on the NRX-A1 reactor design. Reliability consultation was furnished on the NRX-A1 and flight control system designs.

The Kiwi B-5A Shield Assembly Parts Log has been issued. A potential failure rate index analysis was made for each of the electro-pneumatic control drum actuator designs. These analyses are based on the failure-mode analyses of the Bendix and General Electric Actuator designs, as recently completed by WANL.

Bendix continued their reliability design analysis of the TPCV actuator, and reviewed the specifications for this actuator and the torque motor. Their revised Quality Assurance Manual was completed and released.

A plan for electronic processing of NERVA reliability and quality control generated at LRP was developed, together with a cost estimate for conversion from manual data processing.

Preliminary systems have been established for reporting fuel-element process control and inspection data to the reliability and quality data system at WANL.

The outline of a malfunction analysis study of the Overhead Positioning System for the E-MAD building was prepared by AMF atomics, and work on this study has begun.

Item 2.7 SAFETY

A. SAFETY AND HAZARDS EVALUATION

1. NRX-A Safeguards Report

A detailed outline of the NRX-A Safeguards Report is being prepared. This report will be issued later in 1963, at a date to be determined. Information concerning projected NRX-A tests has been accumulated to investigate credible accidents for this series of tests. Present analytical models for NRX-A excursion analysis are being evaluated.

2. WANEF Safety Report

The draft of the Safety Report for the Westinghouse Astronuclear Experimental Facility (C-RD) WANL-TME-085 covering the operation of the NERVA critical experiments has been submitted to SNPO-C. Comments of WANL concerning this draft have been received, but are being held, pending receipt of additional review comments by SNPO.

Additional analysis of the critical organ dose from inhalation of the iodine isotopes has been initiated. These results will be included in the final report, together with revisions from review comments.

3. Reactor Assembly Safety Analysis

Information related to facilities description and operating procedures vital to the safety analysis of the operation has been accumulated, and preparation of the report has been started, with scheduled release for February. Safety analysis of the fuel storage facilities for this operation has been completed. That portion of this report dealing with shipping was submitted to SNPO in November as Draft, Safety Report for Shipping NERVA Reactors (C-RD), WANL-TME-202.

4. RIFT Safety Review Program

The initial report for the RIFT Safety Review Program was issued as REON Report 2421 (C-RD), RIFT Safety Review Program - NERVA. This report provides current design information and operating characteristics for the NERVA engine and its related components. The data presented are for the use of all cooperating groups associated with the RIFT Program to assist in performing a

series of comprehensive safety evaluations and reviews of the NERVA engine in relationship to its intended flight operations. Periodic revisions to this document will be made as significant changes in the design occur, or as additional information becomes available.

B. STUDY OF FUEL ADDITIVES FOR FLIGHT SAFETY

Processing has been completed on graphite mixtures containing 5 w/o Mo, 1 w/o Zr, and 1 w/o Nb, incorporated in the form of carbide additions. An additional batch of undoped reference material has also been produced. Material containing 1 w/o Nb has been "sensitized" at 2750°C as the first part of the study on the effects of thermal excursions.

Eight tensile tests have been conducted on reference material at room temperature to determine base properties. The results indicate a wide variation in tensile properties of material produced and tested in an identical manner, with ultimate tensile strengths ranging from 2800 to 4890 psi.

Tensile and rupture-modulus specimens are being machined from additive-containing materials which have been fired. Production of specimen material containing depleted uranium has commenced.

A standard screening test has been established for comparison of additive materials.

Plots of weight loss as a function of reaction time show a zero order reaction. An optimum Mo addition probably lies between 1% and 5% Mo.

Several other series of oxidation experiments performed during the past month are summarized as follows:

1. At 1200°C and 5 mm and 9 mm pressure, with several flow velocities, it was found that spectroscopic carbon reacted with dry air at a rate 16.6% that of the reaction with pure oxygen. For low flow rates, the gas produced was CO_2, and at high flow rates CO was formed. This is corroborating evidence for the theory of gas phase oxidation of CO as a secondary reaction. Nitrogen acts as an inert gas at 1200°C, since no trace of cyanogen was found by mass spectrograph analysis.

2. The reference graphite mixture tested under the above conditions oxidized at a rate of 60% of that for spectroscopic carbon in both oxygen and air. Oxidation rates in air were 18% of those found for pure oxygen.

3. Results of oxidation tests on 1 w/o additive material at 1200°C indicated a reaction rate at least 100% greater than that of the basic reference mixture.

A modified impact crush test machine has been designed. The purpose of this equipment is to simulate (at temperatures up to 4000°F) the shock loading of fuel material which would occur with most contemplated methods of primary destruct. Investigation of crushed or fractured materials from this machine should help to delineate any effects additives may have on high temperature fracture characteristics.

C. OPERATIONAL SAFETY

Radiochemical analysis of the Kiwi nozzle smears has been completed, and the data are being analyzed. Preparations have been made for obtaining a second set of smear samples from the most recent Kiwi tests. A request has been made to LASL for the continuation of the Kiwi-nozzle sampling program for the NERVA Exhaust System plateout studies.

A preliminary draft of the REON Radiological Safety Policy has been prepared.

A safety survey was performed of the Test Cell "A" Facility at NRDS, for application to the NERVA upward firing and NRX test operations. Recommendations for applicable facility modification have been presented.

A radiological safety review of the ROVER Safety Test Site at Hawthorne, Nevada was performed for future test operations which would use radioactive materials. The basic requirements for a radiological program for the associated test operations have been prepared, and are being reviewed by REON management.

D. MECHANICAL AND PHYSICAL ASPECTS REACTOR EXCURSION

1. TREAT Experiments

The third series of graphite photographic experiments was performed in TREAT during this period. The test parameters and preliminary post-irradiation results for the three experiments in the series are given in Tables I and II.

In the first experiment, pellets of Pyro-carbon coated UC_2 with different average particle sizes were exposed to three reactor transients (150, 240, 325 Mw/sec, at 69.77, and 77 mo, respectively). By means of high speed photography all samples during the first transient exhibited a "popcorn" effect, magnitude of which was greatest for the largest size particle; no similar correlation could be made during the other two transients. All samples appeared to have been fused with indications that considerable scattering had occurred during testing. Percent weight loss of samples varied between 36.1 and 52.3.

The last two experiments involved single transients of 625 and 616 Mw/sec, at 50 mo each on one-half inch samples of NRX-A fuel elements, one specimen containing a small amount of UO_2. Both samples resisted fragmentation at a high transient temperature ($\sim 3400^{\circ}C$) showing no apparent structural damage other than surface porosity. Melting of the NbC liner occurred in both sampling causing partial blockage of the channels.

2. Excursion Analysis

Modifications to the Los Alamos RAC program are being evaluated as a means for calculating neutron kinetics and spatial distribution with a single code. The present RAC code calculates an excursion yield in cylindrical geometry using both vaporization and temperature as a mode of shutdown. Consistent results have been obtained in several test cases involving variations in the reactivity step and maximum allowable density change. Little change was found between a 20 and 40 region description of the core for a 0.01 reactivity step input.

Various schemes are being explored to analyze the physical phenomena during an excursion, including the hydrodynamic assumption. The equations of motion used in the RAC code are being evaluated for applicability. Specific emphasis is being placed on the ability to treat wet and dry excursions of all types.

E. RE-ENTRY SAFETY STUDIES, R&D

Analysis of the data obtained using the re-entry code has been continued.

All samples for the next set of plasmajet tests have been prepared.

A study has been undertaken to determine the extent of burn-up and the re-entry time of small graphite particles on shallow re-entry angles (less than 5^{o}) from an initial altitude of 1,800,000 feet. With the present re-entry code, shallow angle re-entry cases cannot be considered, since calculations involve an excessive amount of computer time. The first step of this work has been to formulate proper analytical expressions which would determine the orbital lifetime from high altitude circular orbits (re-entry on an initial angle of zero degrees).

An analysis was made to determine if any differences existed between re-entry times for particles re-entering with $\pm 1^{o}$ angles from a circular orbit from altitudes of 1,800,000 feet. Results have shown that the re-entry times for both angles are identical.

F. FISSION PRODUCT DIFFUSION STUDIES

The first capsule irradiation for the fission product diffusion program was successfully performed at the GETR. The radiation level of the capsule was 48 mr/hr through 24 inches of water, six hours after withdrawal from the flux.

Item 2.8 TRAINING

A. TRAINING PLAN

The development of a Training Plan was initiated to present a complete plan of activity to be followed in support of Task 2.8. The plan is to include sufficient detail to present a clear understanding of what is to be accomplished, and what will be needed to meet that end. Several tentative plans evolved into one complete plan, which is presently in the final stages of preparation and will be ready for presentation during the next reporting period.

B. JOB DESCRIPTIONS FOR E-MAD FACILITY

Preparation of detailed job descriptions was continued as work was initiated to assist in the development of the forthcoming report, Description of E-MAD Facility being prepared by the Support Systems Department of REON.

C. POST-OPERATIVE SUPPORT EQUIPMENT TRAINING ANALYSIS

An analysis of Support Equipment for the post-operative area of the E-MAD facility was initiated to provide a basis for job and task descriptions to determine training requirements. Equipment descriptions and engineering data are being studied in sufficient detail to determine a general understanding of training required.

D. GRAPHIC ACTIVITY SCHEDULE

A Graphic Activity Schedule is being developed for NERVA training requirements. This chart is now complete so far as available information permits, but will be revised or upgraded as program development progresses.

E. JOB-TASK ANALYSIS STUDY

The Job-Task Analysis Study was continued as work was initiated to determine training requirements for equipment operators and maintenance personnel. Work in this area has been restricted to the collection of data in all phases of the NERVA program. Some analysis has been performed and is sufficient for formulation of a concept for the Training Plan.

F. PSYCHOMOTOR TEST STUDY

A study of psychomotor testing procedures has been initiated to determine if such testing would be of value in the selection of personnel for the Nevada Test Site, and a preliminary draft of the study report has been prepared.

Item 2.9 LASL SUPPORT

Thirty-six technical personnel are currently assigned to LASL support activities.

Item 3.0 GENERAL SUPPORT FACILITIES

A tabulation was made of the telephone stations and extensions comprising the Direct Line and Dial Telephone Subsystems serving the ETS-1 Complex. This information was transmitted to SNPO-C in accordance with their request for use in establishing cable requirements at NRDS.

An updating study was continued on the needs of REON and its subcontractors for general support facilities at NRDS. Space requirements, water, power, telephone, and other special utility demands; severable operational equipment; and support services are being updated in terms of anticipated needs and operational requirements.

Item 3.1 NERVA EXHAUST SYSTEM DEVELOPMENT PROGRAM

Tests to define the criteria for secondary purge flow in the NERVA Exhaust System, while using the LRC-3 duct system, have been completed. These tests evaluated the surge pressures resulting from abrupt cessation of engine flow, penetration of air into the duct, and tolerance of the ejector to high molecular weight secondary purge flow. Data from these tests are being reduced and correlated to aid in defining the specific tests to be run during the redefinition of a NES system for ETS-1.

The test program has been revised and awaits SNPO-C approval.

Item 3.2 TEST STAND ETS-1

A. GENERAL

A meeting, attended by representatives of SNPO-C, SNPO-N, AETRON, REON, and Catalytic Construction Company, was held on 5 and 6 December at AETRON-Covina, to discuss the subject of Facility Checkout of the ETS-1 process systems, Contract No. AT(29-2)1060. Agreement was reached concerning the scope of checkout work to be accomplished by the construction contractor. Minutes of this meeting, prepared by AETRON, are being reviewed by REON with respect to the work to be performed by REON in activation planning. When SNPO-C notifies REON of the effect and influence on the construction contractor task, REON will establish their activation responsibilities.

In response to letter request from SNPO-C, an interim summary of the preliminary REON Report No. 2433 (S/RD), NRDS - Nuclear Rocket Engine Interim Static Test Facility (U), was completed and submitted to SNPO-C, on 28 December 1962.

At request of SNPO-C, PERT information for ETS-1 activation was completed and submitted to them on 28 December 1962.

Preparation of the activation and operational checkout procedures covering the Tank Farm portion of the facility was initiated. The procedures will outline the items of activation work to be performed and will show a time schedule for accomplishing the work.

Refinement of NERVA Engine reactor cool-down requirements is being developed and upon completion, will be examined from the standpoint of facility adequacy.

Review was initiated of design criteria for the engine adapter for compatibility and affect on facility interface requirements.

A study was initiated to determine whether the ETS-1 process systems, as now being constructed, can permit continuous topping of the run tank during engine test run.

Review continued of the gas and fluid systems from the standpoint of protecting the reactor against overheating.

B. NERVA EXHAUST SYSTEM DUCT

In accordance with the request of R. W. Shroeder of SNPO-C on 20 November 1962, REON prepared a program plan for development, design, testing, and fabrication of the supersonic duct for ETS-1, including the associated gas-generator system. A complete program for final design, fabrication, installation and checkout of the NES, to conform to the AGC-2 configuration, including the Technical Administration Documents, technical discussion, program plan, costs and PERT scheduling network, was submitted to SNPO-C on 28 December 1962 as REON Report RN 63003A.

Based upon the request of SNPO-C of 28 December 1962, the program is now being redirected to develop the LRC-3 configuration duct for a 25:1 nozzle and purge system. The program plan for model testing and preliminary design for this configuration is being prepared and will be submitted in February 1963.

The current preliminary design, including the necessary drawings and technical specifications, are in the process of completion. This information will be published in a special REON report.

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Item 3.3 ETS-1 INSTRUMENTATION AND CONTROL

A. I & C System Design

A scheduling and planning meeting was held at the EG&G facilities in Boston on 11 and 12 December 1962. EG&G presented their schedule for conducting the design of the ETS-1 I & C System to representatives of SNPO-C, WANL, and REON. The schedule of EG&G design document submittal and approval has been reviewed by REON, and comments are being prepared.

Technical meetings were held at Sacramento and Azusa on 17 and 18 December to cover Data Systems, and on 19 and 20 December 1962 to cover Facility Systems with representatives from SNPO-C, WANL, EG&G, and REON in attendance. These meetings provided information and guidelines to the I & C contractor concerning REON technical and operational requirements of the various I & C subsystems. Continued effort is being expended in reviewing and upgrading I & C technical requirements.

B. General

The Henry Dreyfuss Company has submitted the preliminary ETS-1 Control Room layout drawings. These drawings have been reviewed and returned, with comments, to the Dreyfuss Company. The final layout drawings and a miniature control room mockup should be completed during the next reporting period.

Efforts are continuing on defining the remote engine control interfaces.

Preparation of the requirements for the engine simulator is continuing.

Item 3.4 TEST STAND ETS-2

Assistance was provided in the preparation of REON Report 2433, NRDS - NERVA Nuclear Rocket Engine Auxiliary Static Test Facility Study, (S/RD), as referenced in the discussion of Item 3.2, for the positioning of an "interim" test stand at the ETS-2 location. Latest engine cool-down and engine adapter interface requirements were reviewed for compatability with the test stand.

Item 3.5 E-MAD BUILDING

REON Report 2325, NERVA Post Operative Requirements and Support Systems Utilization, submitted 25 October 1962 is being expanded, clarified, and updated as requested by SNPO-C

The first element of this effort was presented to SNPO-C in a meeting at Cleveland on 19 December 1962 and included delineation of NERVA Reactor post-operative examinations and test requirements, sequence, priority, time, and level of effort for each engine block In addition, the following items were also discussed. the radiation level criteria for the selection of engine subassemblies and components for warm area or hot cell post operative evaluations and tests; justification of the requirement for cranes and manipulators in metal parts cells; and feasibility of off-site post-operative examinations and test

The second portion of this updating effort is currently in progress, and includes integration of the data presented at the 19 December meeting and formulation of core cell loading distribution This material is scheduled to be completed by 15 January 1963.

The third part of this work in progress is the preparation of final copy of Report No. 2325 by 1 March 1963.

The E-MAD Phase II preliminary design, Vitro Report KLX 1844 E-MAD Facility Phase II Preliminary Design, 2 November 1962, as amended by Drawings 1425-C-205 (12-3-62), 1425-R-207 (12-10-62) and 1425-R-208 (12-11-62), was reviewed to assure adequacy of the facility for the NERVA Program. A response is in preparation for transmittal Because of monetary limitations on construction, SNPO-C requested that REON indicate the minimum permissible E-MAD facility which would permit NERVA operations without severe constraints and by involving only nominal compromise to the NERVA referenc d plan. The salient results of the review on this basis were given at the meeting between representatives of Vitro, WANL, and REON at New York City on 11 December 1962. Briefly, preliminary designs of the following facilities provisions were discussed and approved by REON and WANL as minimal for NERVA operations: general arrangement; shielded windows; cell lighting; heating, ventilating; ...

conditioning; utilities; services; power and controls; intercommunications and television; crane and manipulator coverage, capacity, and height; and turntables.

It was agreed at the meeting on 19 December by ANPO-C, WANL, REON that REON and WANL would review and comment on the remaining portions of Report KLX 1844 after receipt from Vitro of the minutes to the 11 December meeting. These minutes were not received during this reporting period.

Evaluations of the limitations and restrictions of the currently planned Phase II facility are being examined in light of the anticipated NERVA Operations, as defined in RECN Report 2325. Efforts include the evaluation of the effects and operational influences caused by the deferment of seven hot cells, five warm work areas, decontamination area, and dye penetration test areas. The change in NERVA Intercell operations is being evaluated as a result of the decision to design the post-operative cells in a 6 x 6 array instead of the original proposed 7 x 5 array. The evaluation of the effects on the NERVA operations of various type cell doors was completed and transmitted to SNPO-C for action on 8 December 1962.

The effects of the decision by SNPO-C to defer the warm post operative area was evaluated by an analysis of areas within the E-MAD complex which could be expediently used for these functions. The conclusions presented at the meeting of 19 December indicated that, while there does not appear to be adequate available space for the warm area functions, still, on a temporary basis, expedient usage could be made of a number of locations to include: main cold bay, core receiving, balcony, cell service area, etc. Further resolution of this problem is necessary.

The interference of the OPS bridge and the swing-out rail structure was detected and presented in the 11 December meeting, at which time SNPO-C made the decision to change the OPS design. This effort is coordinated with Item 2.1.

The E-MAD Phase I Shielding Report, Vitro Report KLX 1842, has been reviewed and comments of REON and WANL were transmitted to SNPO-C on 4 December 1962. These comments, in general, are in agreement with the discussion by TWX to SNPO-C on 26 July 1962, on 13 and 14 December, and on 3 and 4 October 1962.

Work is continuing on the E-MAD plans and procedures for NERVA NRDS Operations. The current effort includes a literature search and survey, compilation, evaluation, and analysis. The E-MAD test plan and procedure for NERVA NRDS operations document will be a comprehensive NERVA Assembly, Disassembly, and Maintenance (MAD) document, and will include in addition to NERVA "MAD" plans and procedures, facilities operations and maintenance plans, and all other aspects of NERVA MAD operations required to define complete E-MAD Complex operations.

Item 3.6 REACTOR DEVELOPMENT FACILITY

Studies are being conducted to determine the signal conditioning capabilities of the Test Cell "A" Data System. This information will be required to determine whether current Test Cell A equipment will meet NRX-A testing requirements for signal conditioning.

A review was initiated of the LN_2 System specifications and requirements as proposed by LASL to be an alternate for the GN_2 storage tanks required at Test Cell "A".

Gas requirements for reactor cool-down for NRX are being calculated on a maximum core temperature.

Preliminary studies for utilization of Test Cell "A" as an interim stand for testing the E-engine were completed and reported in REON Report 2433, 28 December 1962.

Item 3.7 RADIATION EFFECTS FACILITY

It is anticipated that the effort on this task will be resumed in January, 1963, after the inter-agency agreements regarding the Convair-Fort Worth ASTR Facility modifications and operations have been established in final form, and after SNPO-C has selected an architect-engineer to design the appropriate facilities required for conducting the NERVA irradiation tests. Nominal orientation and indoctrination of personnel assigned to the task is being conducted, but other work under this Item has been suspended, pending direction to proceed from SNPO-C.

Item 3.8 NRDS RADIOACTIVE MATERIALS HANDLING, DECONTAMINATION, AND STORAGE COMPLEX

A definitive plan for carrying out the work under this task was completed. Detailed data requirements were developed to guide the continuing effort to define radioactive materials (including sources, characteristics, and functional storage requirements) resulting from engine operations and post-operative examinations at NRDS.

Effort is continuing in the development of detailed flow diagrams to identify functional and process flow of radioactive materials, and in the definition of operational and functional requirements for this facility.

Item 3.9 RIFT STAGE DEVELOPMENT FACILITIES

There was no activity in this item during this reporting period.

SECTION III (cont.)

TECHNICAL DISCUSSION

TASK 4.0 PROGRAM MANAGEMENT

Item 4.1 PROGRAM PLANNING AND CONTROL

During this report period, new subcontractor level networks were prepared for the Irradiation Program and the Non-Nuclear Engine, and related STE and GSE for the Hot-Bleed program, as presented in AGC Report 2434. These networks were reviewed by REON program planners and subsequently revised and expanded by the Liquid Rocket Plant. REON Control networks were prepared for Task Items 3.1, 3.2, 5.1, and 5.3, and included in the NERVA Exhaust System Program Plan (AGC Report RN 63003A) in accordance with the request of SNPO-C. Preliminary REON Control networks were prepared for Task Items 1.3 and 2.7, and a computer run was made of the network for Item 1.3. Preliminary drafts of key event networks for summarized program definition were prepared on various engine and equipment subtasks.

A computer run was made of the negotiated program as presented in Report 2322, for purposes of checking schedules and milestones. Normal biweekly PERT reports were prepared and submitted to SNPO-C as required.

Item 4.2 FISCAL CONTROL

The monthly Fiscal Supplement to the November Progress Letter was prepared and submitted to SNPO-C.

Item 4.3 ADDITIONAL DOCUMENTATION

The following additional documents were prepared and published during the report period.

REON Report No.	Date Transmitted	Title	Report Classification
2421	12-1-62	RIFT Safety Review Program NERVA Systems Description (U)	C-RD
2434	12-3-62	Revised NERVA Engine Program and Associated Tasks (U)	C
2276	12-6-62	Engine Systems Data Book (U)	C-RD
2433	12-28-62	Preliminary NRDS NERVA Nuclear-Rocket	S-RD
2466	12-14-62	Revised Radiation Effects Technical Discussion, Test Schedule and Test Plans, CY 1963	C
2467	12-29-62	Program Planning Details, NERVA Component Radiation Program, GD/FW	U
		Engine Auxiliary Static Test Facility Study (U)	U
RN-63003A	12-28-62	Revised NERVA Program Plan for the NERVA Exhaust System for ETS-1	U
	12-5-62	Weekly TWX Report No. 7	U
	12-12-62	Weekly TWX Report No. 8	U
	12-19-62	Weekly TWX Report No. 9	U
	12-26-62	Weekly TWX Report No. 10	U
	12-17-62	Monthly Progress Letter No. 17 (U)	C-RD

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Item 4.4 NERVA CENTRAL DATA SYSTEM

Work was continued on the Reliability and Quality Control Data requirements and in processing AGC drawings for magnetic storage.

The XEROX 1824 electrostatic printer for reproduction of microfilm was received and a 35-mm camera was ordered. Delivery of the camera will be made the second week of January 1963.

Engineering data from AGC-LRP is approximately 50% complete, and a complete set will be entered by the third week in January.

Layout drawings from WANL were received and entered into the data system.

Bendix drawings will be received on 35-mm microfilm in January for entry in the Data System.

Additional error checking routines are being added to the computer programs to ensure accurate entry and updating of the master file.

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Item 4.5 SUBCONTRACT ADMINISTRATION

Letter contracts authorizing interim funds to continue work through 31 January 1963, have been issued to Westinghouse (NP-1), Bendix (NP-2), and AMF (NP-3) pending execution of Supplemental Agreement to SNP-1 for Contract Year 1963.

Contents of Project Directive 149 were forwarded to major subcontractors as a guide in the preparation of a program plan for reliability and quality assurance for the period 1 April 1963 through 30 September 1963.

Proposed amendments to Work Statements for Westinghouse Projects 1342, 1981, and 5000 have been received by REON, and that for Westinghouse Project 1980 is being reviewed by WANL management.

The performance of NUMEC (Nuclear Metals Corp.), sub-subcontractor for the SS material work under Westinghouse purchase order, has been reviewed and the report will be submitted to SNPO-C.

Preliminary negotiations have been initiated with Rocketdyne for the proposed subcontract Mark 15 turbopump

Subcontract NP-5, Amendment No. 1, and Supplemental Agreement No. 1, and Subcontract NP-8, all with General Dynamics/Fort Worth, have received final approval by the Contracting Officer. Subcontract NP-5, Supplemental Agreement No. 1, covers materials irradiation testing for Contract Year 1963.

REON PURCHASE ORDER ACTIVITY

Originator	No. of P.O.'s	Total Dollar Value	Dollar Value Subcontracts Placed
Azusa	4	$ 85,580.40	
LRP	13	320,184.52	
AETRON	13	451,283.54	
Downey	1	1,650.00	
WANL	15	675,753.41	$* 2,916,208
Bendix	0	0	* 75,000
AMF			* 125,000
GD/FW			241,193
Total	46	$1,534,351.67	$ 3,357,401
Awaiting Action First of Report Period	1	$ 5,458.00	
Action Completed During Report Period	41	1,280,944.50	
Awaiting Action End of Report Period	6	258,865.17	

*Indicates Letter of Authorization to Subcontractor.

Item 5.0 SPECIAL TEST EQUIPMENT
WANL

A test rig for measuring the frictional properties of ball bearing materials under oscillating conditions has been constructed. This rig was designed to be perated remotely in a hot shop, and will be used for tests of both irradiated and unirradiated specimens.

Fabrication continued of component parts necessary for the conversion of the test loop to vertical flow in the test section continued. Procurement is currently underway of multi-pass test sections and modifications for simulating reflector heating.

Item 5.1 SPECIAL TEST EQUIPMENT
AGC (LRP - TEST ZONE "C")

Receipt of formal bids covering fabrication of the Ejector System was completed, and the purchase requisition was initiated. The request for SNPO approval is being transmitted to Cleveland.

Approval for the change order covering contractor-performed activation of Test Stand C-6 was received from SNPO the latter part of December. Proposed scheduling calls for completion of contractor effort by 27 January 1963.

Item 5.2 SPECIAL TEST EQUIPMENT
AGC (LRP - TEST ZONE "A") CRYOGENICS LABORATORY

Installation of mechanical and instrumentation special test equipment continued through the month of December. All portions of the vacuum-jacketed piping system have been installed and are currently being checked out.

Numerous change orders were processed, approved, and completed during December. All of these change orders involved minor mechanical or instrumentation modifications (both field and design) necessary to provide a properly operating cryogenic facility.

Installation of the interim bearing tester was accomplished in Test Stand G-7 for final checkout prior to installation on the Irradiation Test Pallet.

Item 5.3 SPECIAL TEST EQUIPMENT
AGC (LRP - TEST ZONE "H")

Formal bids were received, reviewed, and evaluated for performance of work included under Instrumentation and Control STE, Bid Package No. 9. Official contract award will be completed following receipt of SNPO approval.

Installation of Test-Complex piping and mechanical equipment continued throughout the month of December. The previously scheduled contractor completion date of 21 February 1963 is undergoing revision because of the late delivery of vacuum-jacketed piping. Discussions were held between representatives of AETRON, the contractor, and LRP to determine causes for the delay and to make a corrective solution. The contractor is to submit a revised construction schedule, based upon a new delivery date for the piping, by 1 January 1963.

Item 5.4 SPECIAL TEST EQUIPMENT
AGC (STE - AGC), AZUSA PLANT

The PACE 231R analog computer on order from Electronic Associates has been rescheduled for delivery on 1 February. The delay is due to engineering difficulties encountered in the production of the electronic mode control.

The internal wiring of the temperature-controlled oven for the modernization of the 16-24D PACE analog computer is 60% completed. The completed wiring includes all amplifiers, servo multipliers, coefficient potentiometers, trunks, and power. The control panel from Comcor has been delayed until the 15th of January. Comcor states the delay was necessary to insure complete checkout of the read-in - read-out of the servo-set potentiometers.

Item 5.5 SPECIAL TEST EQUIPMENT
AGC (DOWNEY ORDNANCE DIVISION)

The availability and sources for a number of items of STE required for use in the Destruct System Program, were thoroughly checked during the month of December. The purchase requisitions for several of the more urgently required items of STE were initiated.

Item 5.7 SPECIAL TEST EQUIPMENT
AGC (LRP TEST STAND G-7)

The interim bearing tester was installed on Test Stand G-7 for preliminary tests prior to mounting on the irradiation test pallet.

SECTION III (cont.)

TECHNICAL DISCUSSION

TASK 6.0 GOVERNMENT PROPERTY

Item 6.1 GOVERNMENT PROPERTY
AGC (LRP - TEST ZONE "B")

Normal activity is continuing.

Item 6.2 GOVERNMENT PROPERTY
AGC (LRP - TEST ZONE "A")

Normal activity is continuing.

IV. PROGRESS STATUS

The accompanying charts present task milestones as selected for the various contract tasks of the Work Statement. Certain of the items cannot be readily programmed by discrete milestone events, and charts have not been prepared for these items.

These milestone charts are the same as included with the various NERVA Technical Administration Documents presented in REON R port 2322 (C/RD), entitled Program Plan Contract Year 1963, NERVA Engine Development Program and Associated Tasks (U), November 1962. For certain task items, the applicable milestone charts for the Hot-Bleed engine cycle program have been included from REON Report 2434 (C/RD), entitled Revised NERVA Engine Program and Associated Tasks, Contract Year 1963 (U), December 1962.

These charts have been updated to reflect progress through December 1962. Where milestones have been accomplished, the appropriate completion symbol has been added to the chart. If a scheduled milestone has not been accomplished, a r scheduling has been indicated and discussion presented in the following paragraphs.

Task Item 1.3 Nuclear Subsystem

Milestone No. 29 - Release Detail Design of Cooled Bottom Support Plate

This milestone is delayed until January pending release of drawings from LASL.

Milestone No. 30 - Start Fabrication Cooled Bottom Support Plate

Procurement problems have delayed this milestone until January.

Milestone No. 37 - Kiwi-B5 Shield Flow Verification Test Analysis

This is delayed until January because analysis of the original test data is not complete.

Milestone No. 70 - Select Candidate Electro-pneumatic Actuator Design

This is delayed until January to allow time for completion of performance testing.

Milestone No. 71 - Select Candidate Electro-mechanical Actuator

Because of WANL-TME-180 Revision 1, dated 29 October 1962, this milestone has been rescheduled to June.

Milestone No. 76 - Specifications for NRX-A Nuclear Instrumentation Issued

This has been delayed until January due to continuing engineering study and analysis.

Milestone No. 103 - Start Enriched Fuel Elements Flow Testing for Process Control

The delivery of loaded fuel elements has been delayed. This milestone is rescheduled to February.

Task Item 1.5 Engine Controls

Because of design problems encountered by the computer supplier, the delivery schedule of STE of Task Item 5.4 has been delayed until 1 February 1963. Allowance of an additional month for checkout of the equipment makes it necessary to re-evaluate and reschedule some of the milestones of Task Item 1.5. This rescheduling will be reported in the next letter report.

Task Item 2.3 GSE-Transport, Ground Handling, and Maintenance

Milestones 6, 7, and 8 have been rescheduled following a recent review of the LRP/REON PERT diagrams. The original CFDTS test date was 1 May 1963, and the original CFDTS assembly date was 1 April 1963.

Task Item 2.6 Reliability and Quality Control

Milestone No. 5 - Revised Reliability and Quality Control Program Plans Submitted to REON

This milestone has been rescheduled to 22 January to permit preliminary review of plans by REON personnel at participating plants prior to submission.

Milestone No. 7 - Complete Test Plan Evaluation Gen II Mod 1B Simulator

This milestone has been eliminated because of a decision to cancel the test series.

Milestone No. 9 - Issue NRX-A Reactor Failure Mode Analysis Report

This milestone has been rescheduled to 28 February to permit detailed reliability analysis of problem areas indicated by Kiwi B-4A test.

Task Item 2.7 Safety

Milestone No. 10 - Proof Test Safeguards Report Issued

This milestone is delayed until January. The preliminary report is prepared and in review.

Task Item 5.9 STE-AGC (LRP Laboratory Facilities)

Milestone Nos. 9, 10, and 16

These milestones have been rescheduled to be compatible with the Hot-Bleed Test Schedules.

Task Item 6.2 Government Property, AGC (LRP - Test Zone "A")

Milestone No. 22 - Complete Installation of Precision Voltmeter

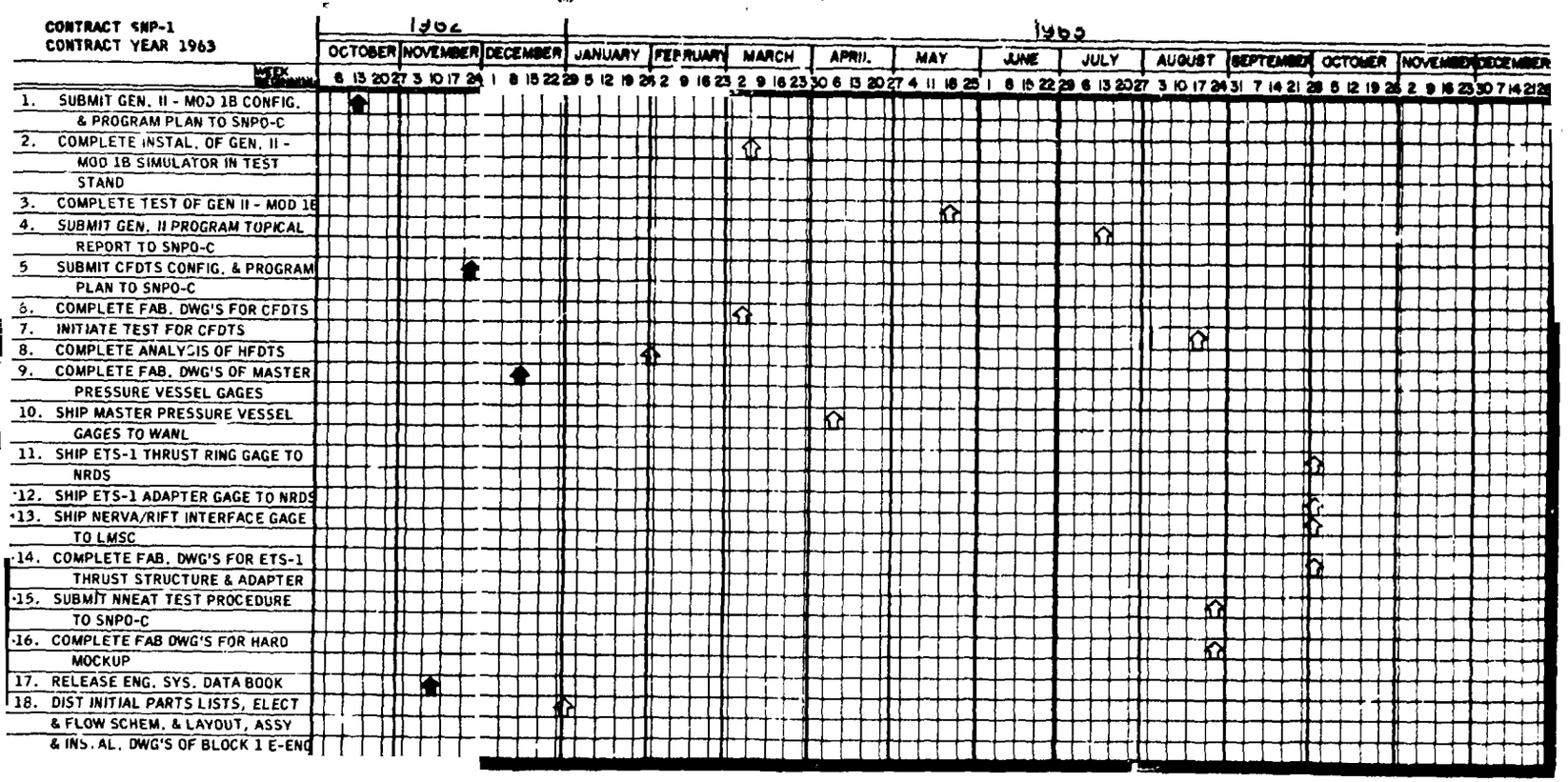
This milestone has been rescheduled to March because of a delay in procurement activities.

Additional changes in future mileposts are required as a result of recent program redirections such as in Task 1.1, and more current scheduling information from AMF in Task 2.1. The next report will reflect these downstream changes.

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.1
ENGINE SYSTEM

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
8 15 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
1. SUBMIT GEN. II - MOD 1B CONFIG. & PROGRAM PLAN TO SNPO-C
2. COMPLETE INSTAL. OF GEN. II - MOD 1B SIMULATOR IN TEST STAND
3. COMPLETE TEST OF GEN II - MOD 1B
4. SUBMIT GEN. II PROGRAM TOPICAL REPORT TO SNPO-C
5 SUBMIT CFDTS CONFIG. & PROGRAM PLAN TO SNPO-C
6. COMPLETE FAB. DWG'S FOR CFDTS
7. INITIATE TEST FOR CFDTS
8. COMPLETE ANALYSIS OF HFDTS
9. COMPLETE FAB. DWG'S OF MASTER PRESSURE VESSEL GAGES
10. SHIP MASTER PRESSURE VESSEL GAGES TO WANL
11. SHIP ETS-1 THRUST RING GAGE TO NRDS
12. SHIP ETS-1 ADAPTER GAGE TO NRDS
13. SHIP NERVA/RIFT INTERFACE GAGE TO LMSC
14. COMPLETE FAB. DWG'S FOR ETS-1 THRUST STRUCTURE & ADAPTER
15. SUBMIT NNEAT TEST PROCEDURE TO SNPO-C
16. COMPLETE FAB DWG'S FOR HARD MOCKUP
17. RELEASE ENG. SYS. DATA BOOK
18. DIST INITIAL PARTS LISTS, ELECT & FLOW SCHEM. & LAYOUT, ASSY & INSTAL. DWG'S OF BLOCK 1 E-ENG

◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

Figure 1
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REON

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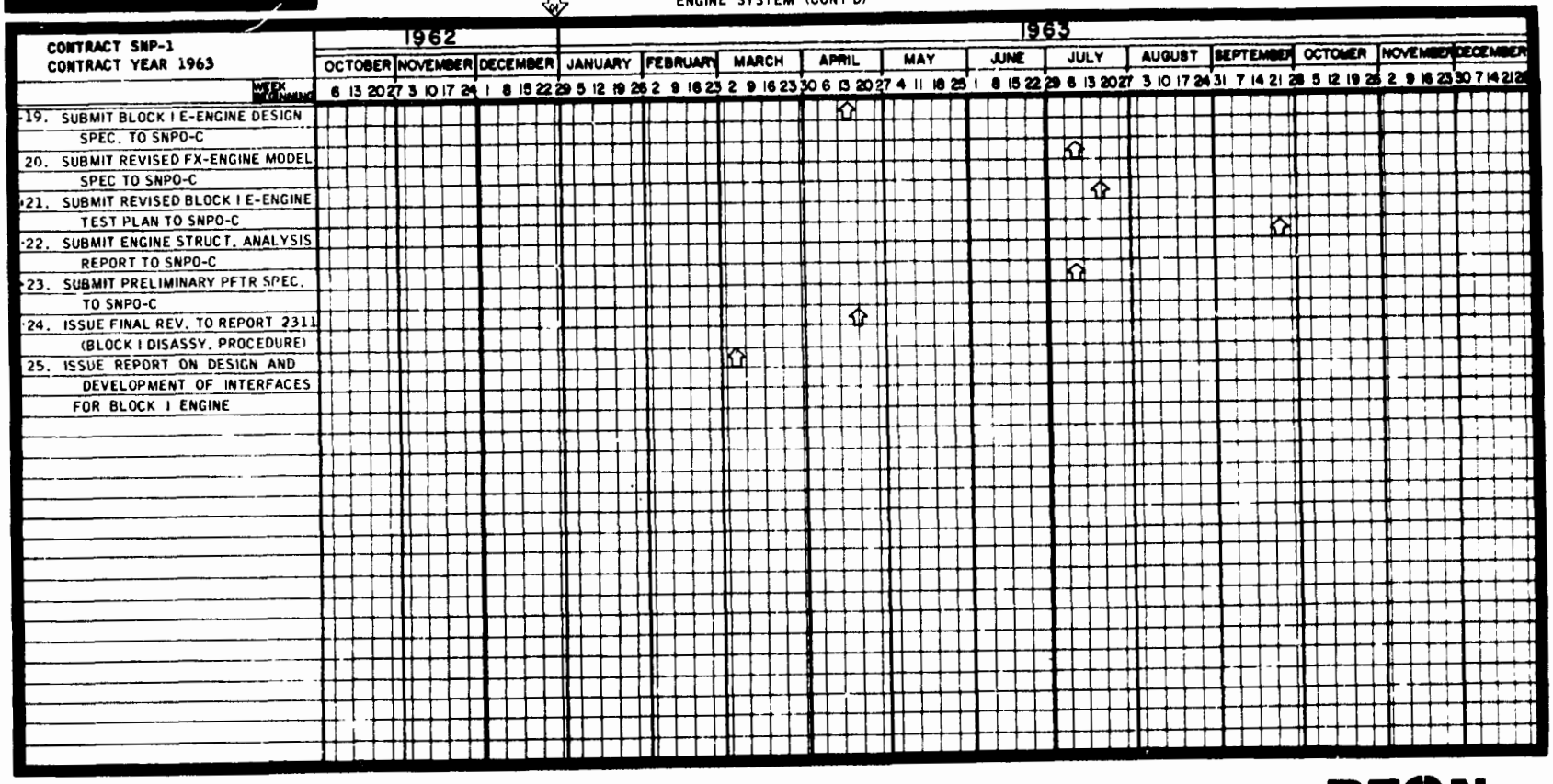
NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.1
ENGINE SYSTEM (CONT'D)


CONTRACT SNP-1
CONTRACT YEAR 1963
WEEK BEGINNING
1962
1963
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
19. SUBMIT BLOCK I E-ENGINE DESIGN SPEC. TO SNPO-C
20. SUBMIT REVISED FX-ENGINE MODEL SPEC TO SNPO-C
21. SUBMIT REVISED BLOCK I E-ENGINE TEST PLAN TO SNPO-C
22. SUBMIT ENGINE STRUCT. ANALYSIS REPORT TO SNPO-C
23. SUBMIT PRELIMINARY PFTR SPEC. TO SNPO-C
24. ISSUE FINAL REV. TO REPORT 2311 (BLOCK I DISASSY. PROCEDURE)
25. ISSUE REPORT ON DESIGN AND DEVELOPMENT OF INTERFACES FOR BLOCK I ENGINE

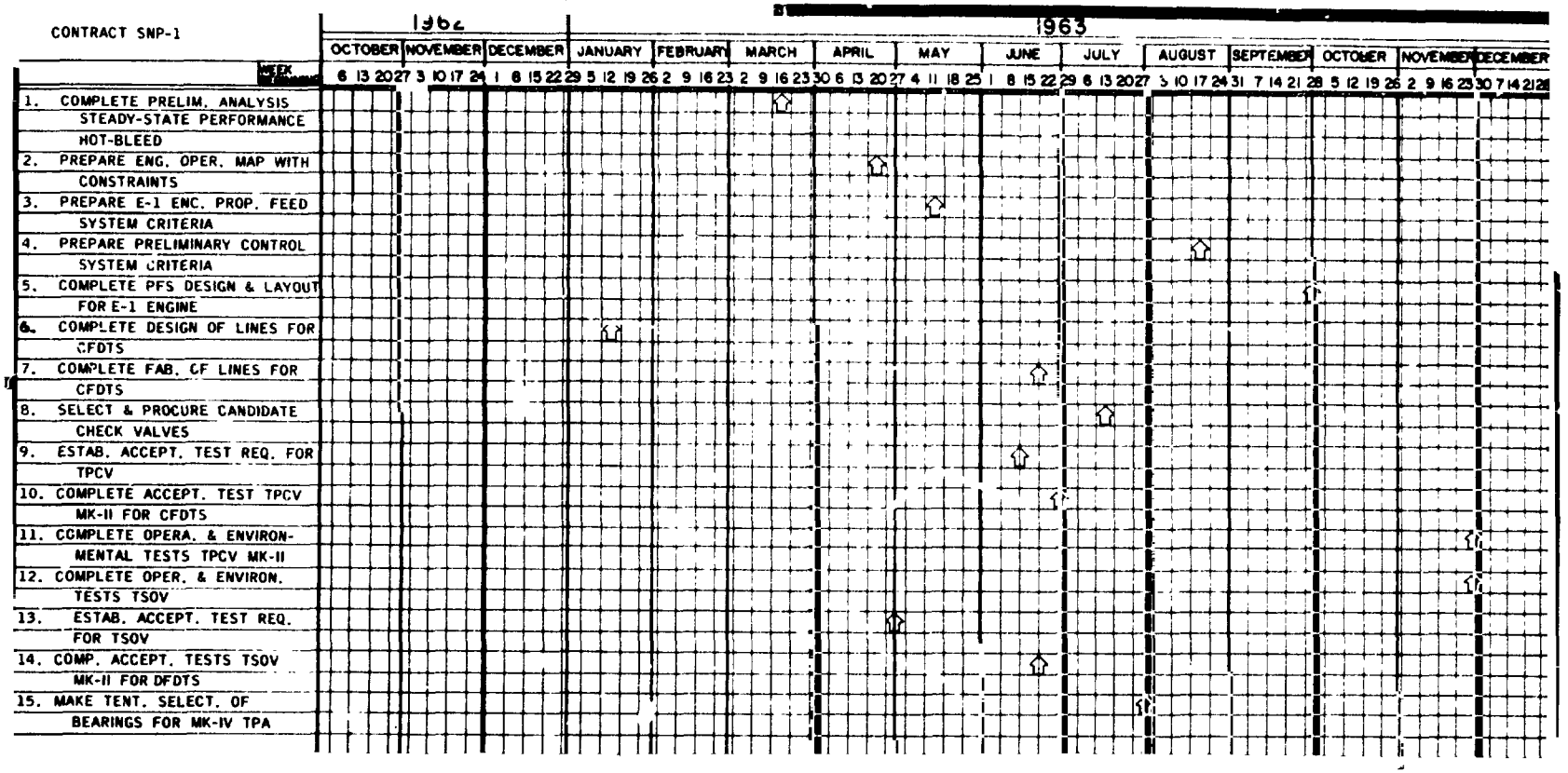
◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 2 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.2
PROPELLANT FEED SYSTEM


CONTRACT SNP-1
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
1. COMPLETE PRELIM. ANALYSIS STEADY-STATE PERFORMANCE HOT-BLEED
2. PREPARE ENG. OPER. MAP WITH CONSTRAINTS
3. PREPARE E-1 ENG. PROP. FEED SYSTEM CRITERIA
4. PREPARE PRELIMINARY CONTROL SYSTEM CRITERIA
5. COMPLETE PFS DESIGN & LAYOUT FOR E-1 ENGINE
6. COMPLETE DESIGN OF LINES FOR CFDTS
7. COMPLETE FAB. OF LINES FOR CFDTS
8. SELECT & PROCURE CANDIDATE CHECK VALVES
9. ESTAB. ACCEPT. TEST REQ. FOR TPCV
10. COMPLETE ACCEPT. TEST TPCV MK-II FOR CFDTS
11. COMPLETE OPERA. & ENVIRON-MENTAL TESTS TPCV MK-II
12. COMPLETE OPER. & ENVIRON. TESTS TSOV
13. ESTAB. ACCEPT. TEST REQ. FOR TSOV
14. COMP. ACCEPT. TESTS TSOV MK-II FOR DFDTS
15. MAKE TENT. SELECT. OF BEARINGS FOR MK-IV TPA

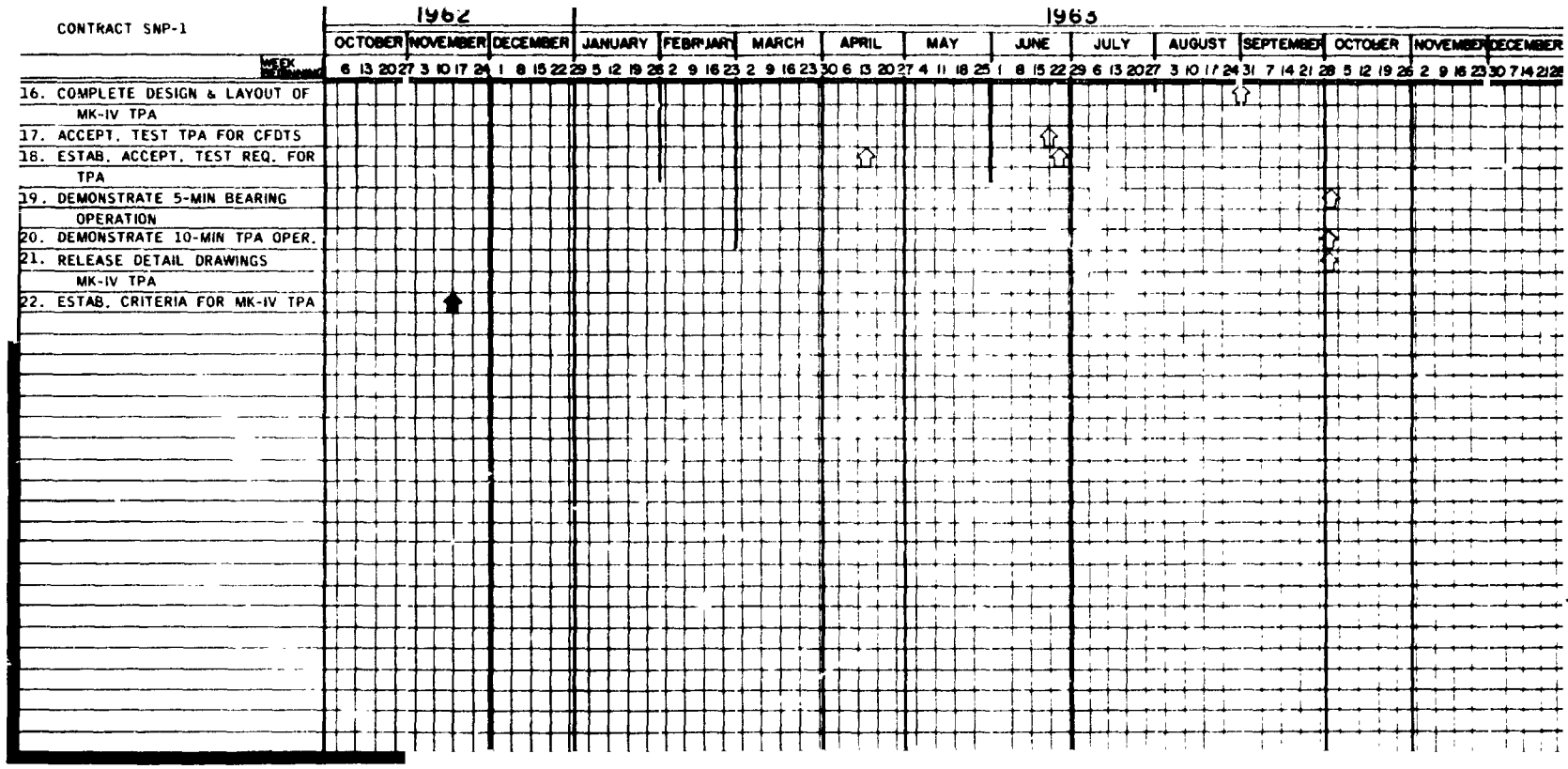
◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 3 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.2
PROPELLANT FEED SYSTEM


CONTRACT SNP-1
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
16. COMPLETE DESIGN & LAYOUT OF MK-IV TPA
17. ACCEPT. TEST TPA FOR CFDTS
18. ESTAB. ACCEPT. TEST REQ. FOR TPA
19. DEMONSTRATE 5-MIN BEARING OPERATION
20. DEMONSTRATE 10-MIN TPA OPER.
21. RELEASE DETAIL DRAWINGS MK-IV TPA
22. ESTAB. CRITERIA FOR MK-IV TPA

⇧ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
⬆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

Figure 1
Sheet 4 of 54

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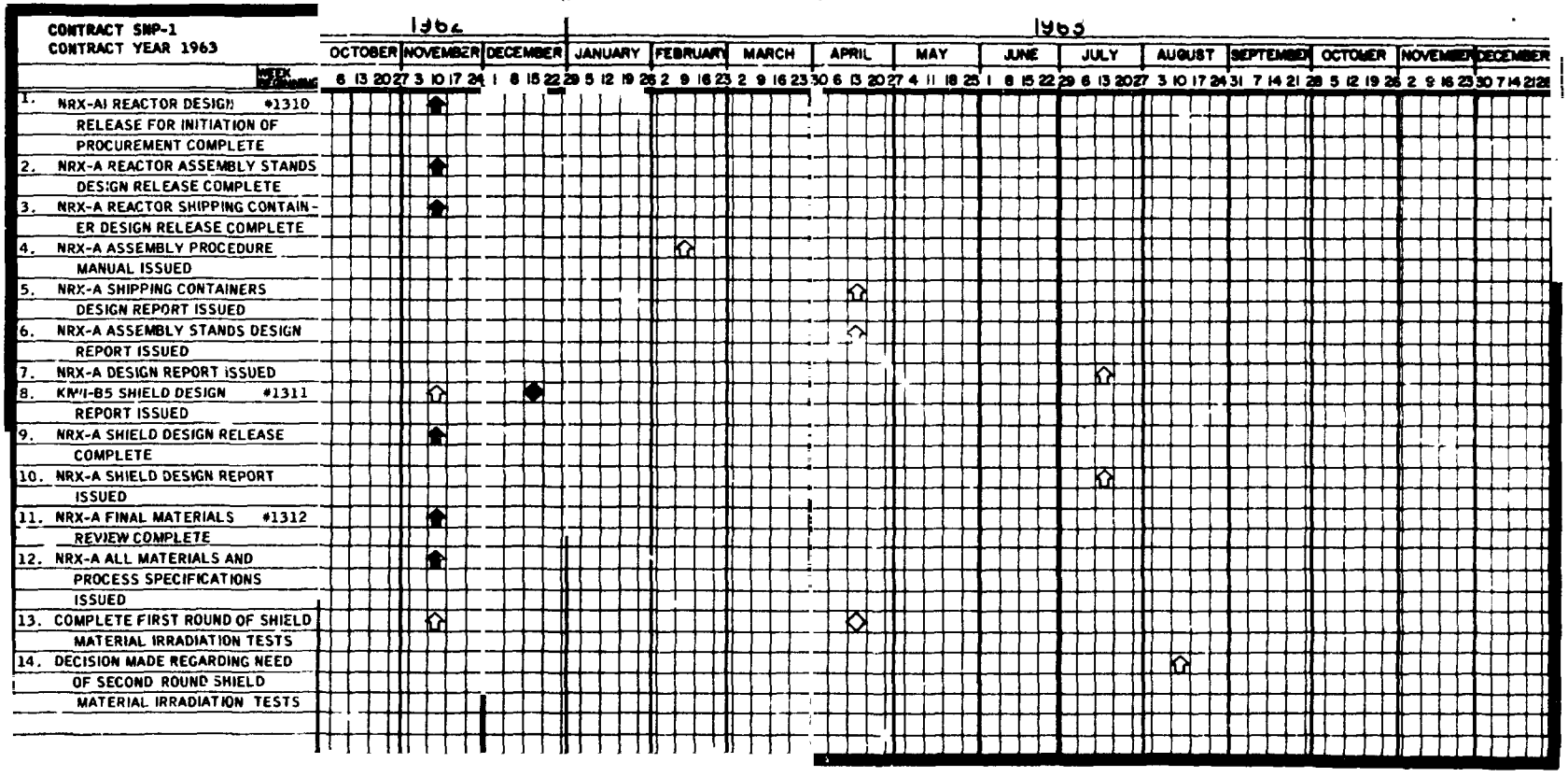
NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.3
NUCLEAR SUBSYSTEM

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
WEEK OF MONTH
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
1. NRX-A1 REACTOR DESIGN #1310 RELEASE FOR INITIATION OF PROCUREMENT COMPLETE
2. NRX-A REACTOR ASSEMBLY STANDS DESIGN RELEASE COMPLETE
3. NRX-A REACTOR SHIPPING CONTAINER DESIGN RELEASE COMPLETE
4. NRX-A ASSEMBLY PROCEDURE MANUAL ISSUED
5. NRX-A SHIPPING CONTAINERS DESIGN REPORT ISSUED
6. NRX-A ASSEMBLY STANDS DESIGN REPORT ISSUED
7. NRX-A DESIGN REPORT ISSUED
8. KW-B5 SHIELD DESIGN #1311 REPORT ISSUED
9. NRX-A SHIELD DESIGN RELEASE COMPLETE
10. NRX-A SHIELD DESIGN REPORT ISSUED
11. NRX-A FINAL MATERIALS #1312 REVIEW COMPLETE
12. NRX-A ALL MATERIALS AND PROCESS SPECIFICATIONS ISSUED
13. COMPLETE FIRST ROUND OF SHIELD MATERIAL IRRADIATION TESTS
14. DECISION MADE REGARDING NEED OF SECOND ROUND SHIELD MATERIAL IRRADIATION TESTS

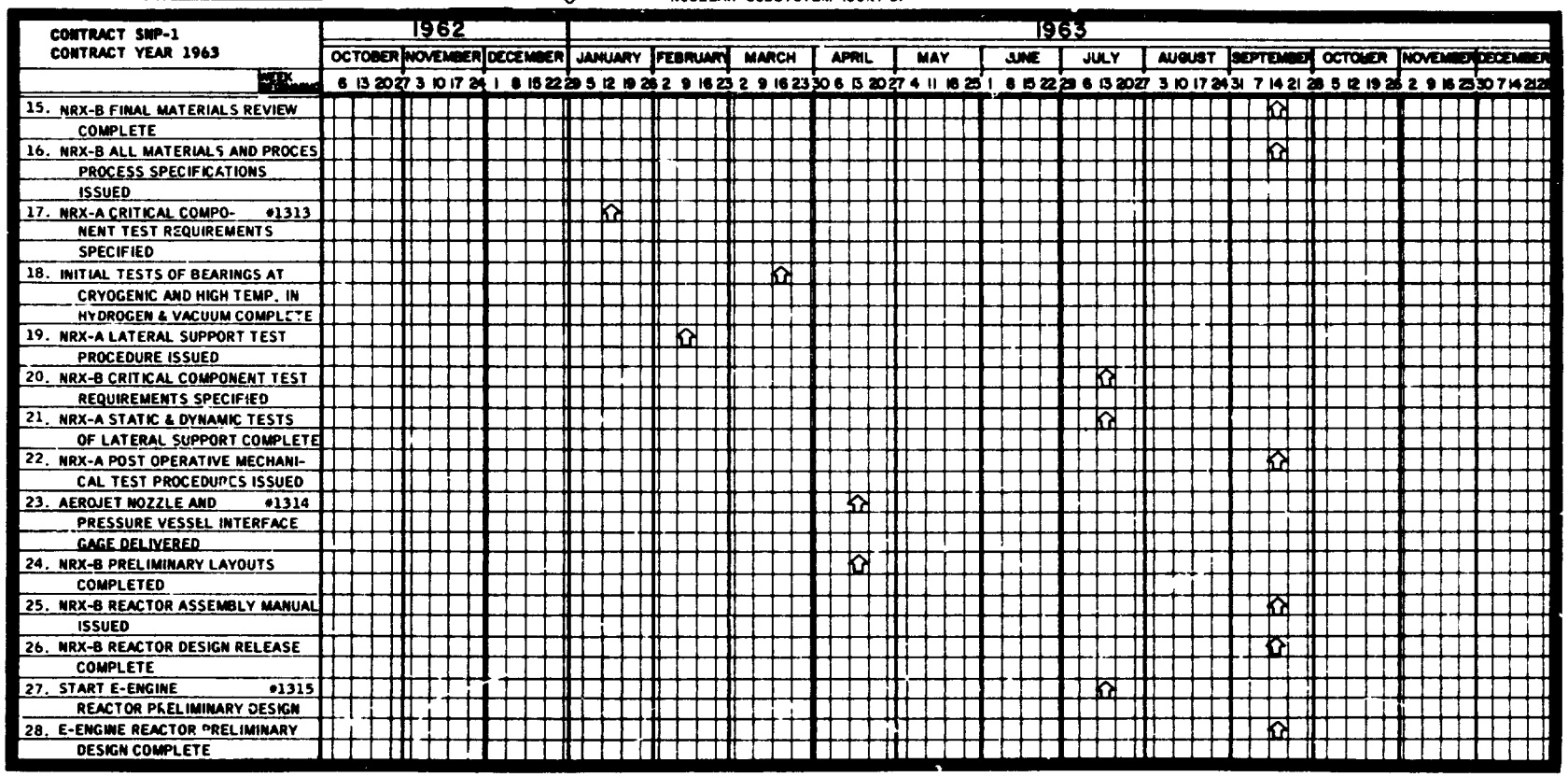
⇧ SCHEDULED MILESTONE
⇩ RESCHEDULED MILESTONE
⬆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 5 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.3
NUCLEAR SUBSYSTEM (CONT'D)


CONTRACT SNP-1
CONTRACT YEAR 1963
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WORK WEEK
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
15. NRX-B FINAL MATERIALS REVIEW COMPLETE
16. NRX-B ALL MATERIALS AND PROCES PROCESS SPECIFICATIONS ISSUED
17. NRX-A CRITICAL COMPO- #1313 NENT TEST REQUIREMENTS SPECIFIED
18. INITIAL TESTS OF BEARINGS AT CRYOGENIC AND HIGH TEMP. IN HYDROGEN & VACUUM COMPLETE
19. NRX-A LATERAL SUPPORT TEST PROCEDURE ISSUED
20. NRX-B CRITICAL COMPONENT TEST REQUIREMENTS SPECIFIED
21. NRX-A STATIC & DYNAMIC TESTS OF LATERAL SUPPORT COMPLETE
22. NRX-A POST OPERATIVE MECHANI- CAL TEST PROCEDURES ISSUED
23. AEROJET NOZZLE AND #1314 PRESSURE VESSEL INTERFACE GAGE DELIVERED
24. NRX-B PRELIMINARY LAYOUTS COMPLETED
25. NRX-B REACTOR ASSEMBLY MANUAL ISSUED
26. NRX-B REACTOR DESIGN RELEASE COMPLETE
27. START E-ENGINE #1315 REACTOR PRELIMINARY DESIGN
28. E-ENGINE REACTOR PRELIMINARY DESIGN COMPLETE

⇧ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
⬆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
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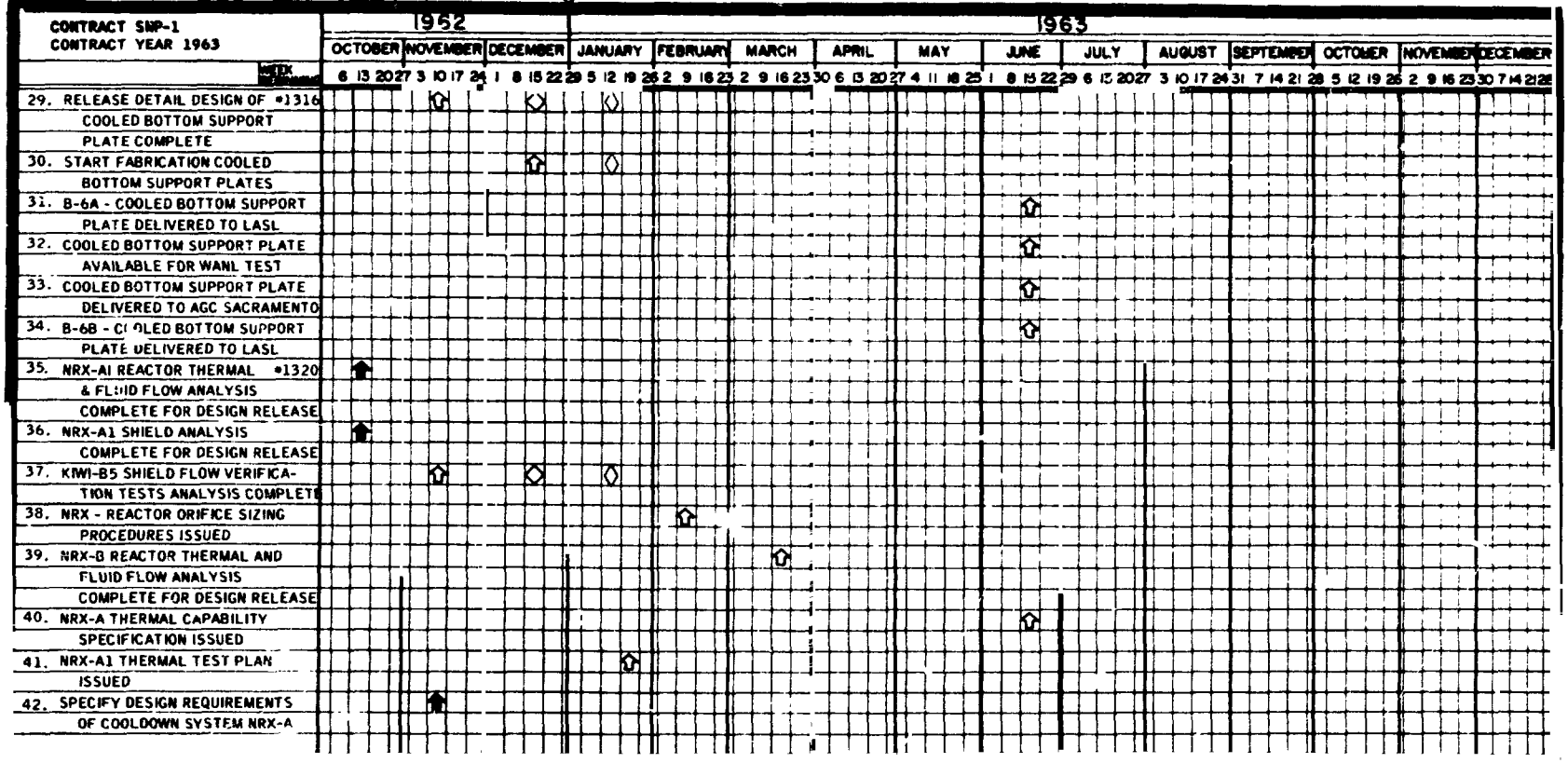
NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.3
NUCLEAR SUBSYSTEM (CONT'D)


CONTRACT SNP-1
CONTRACT YEAR 1963
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
29. RELEASE DETAIL DESIGN OF *1316 COOLED BOTTOM SUPPORT PLATE COMPLETE
30. START FABRICATION COOLED BOTTOM SUPPORT PLATES
31. B-6A - COOLED BOTTOM SUPPORT PLATE DELIVERED TO LASL
32. COOLED BOTTOM SUPPORT PLATE AVAILABLE FOR WANL TEST
33. COOLED BOTTOM SUPPORT PLATE DELIVERED TO AGC SACRAMENTO
34. B-6B - COOLED BOTTOM SUPPORT PLATE DELIVERED TO LASL
35. NRX-A1 REACTOR THERMAL *1320 & FLUID FLOW ANALYSIS COMPLETE FOR DESIGN RELEASE
36. NRX-A1 SHIELD ANALYSIS COMPLETE FOR DESIGN RELEASE
37. KIWI-B5 SHIELD FLOW VERIFICATION TESTS ANALYSIS COMPLETE
38. NRX - REACTOR ORIFICE SIZING PROCEDURES ISSUED
39. NRX-B REACTOR THERMAL AND FLUID FLOW ANALYSIS COMPLETE FOR DESIGN RELEASE
40. NRX-A THERMAL CAPABILITY SPECIFICATION ISSUED
41. NRX-A1 THERMAL TEST PLAN ISSUED
42. SPECIFY DESIGN REQUIREMENTS OF COOLDOWN SYSTEM NRX-A

◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
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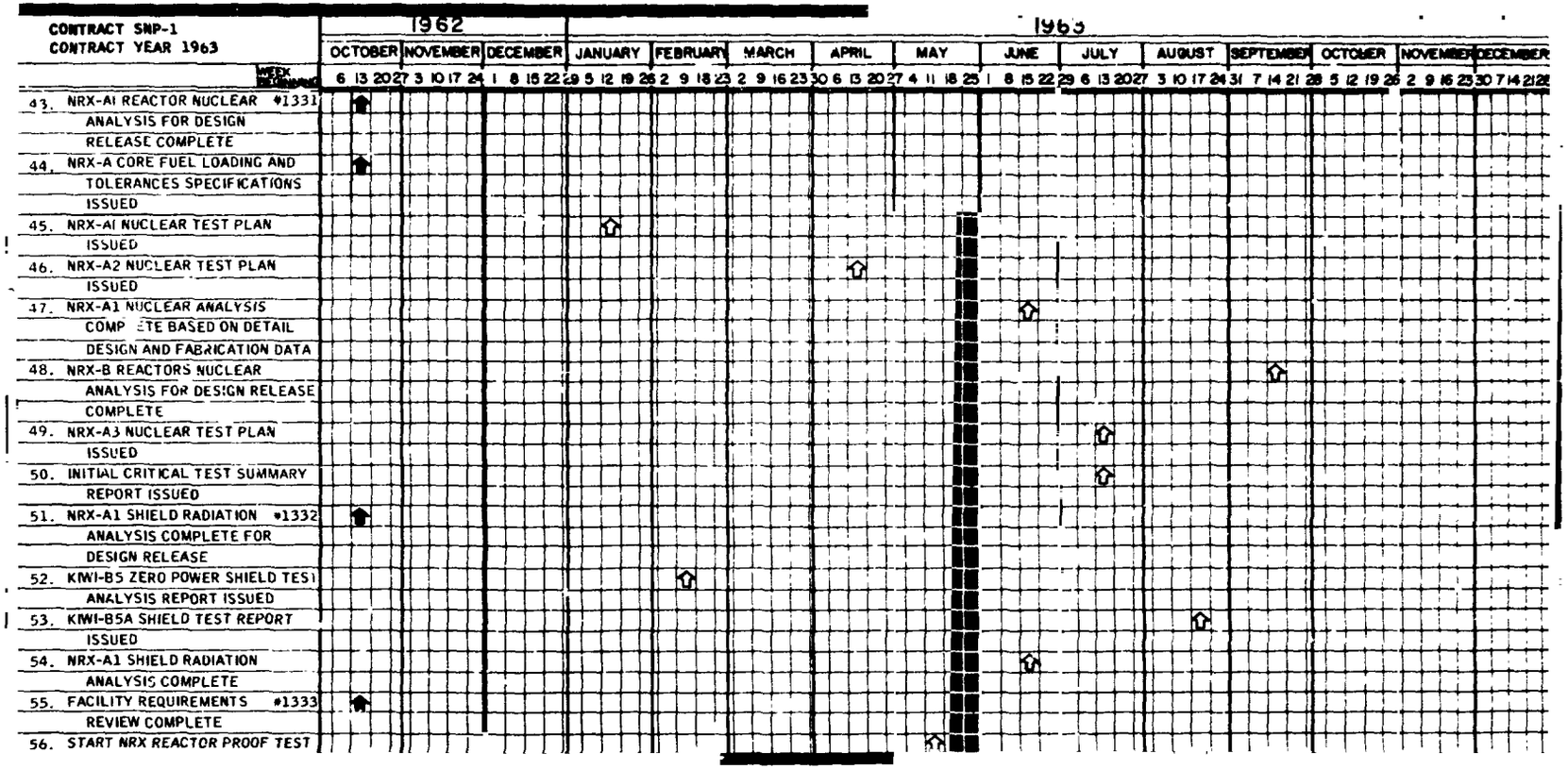
NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.3
NUCLEAR SUBSYSTEM (CONT'D)


CONTRACT SNP-1
CONTRACT YEAR 1963
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 18 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
43. NRX-A1 REACTOR NUCLEAR #1331
ANALYSIS FOR DESIGN
RELEASE COMPLETE
44. NRX-A CORE FUEL LOADING AND
TOLERANCES SPECIFICATIONS
ISSUED
45. NRX-A1 NUCLEAR TEST PLAN
ISSUED
46. NRX-A2 NUCLEAR TEST PLAN
ISSUED
47. NRX-A1 NUCLEAR ANALYSIS
COMPLETE BASED ON DETAIL
DESIGN AND FABRICATION DATA
48. NRX-B REACTORS NUCLEAR
ANALYSIS FOR DESIGN RELEASE
COMPLETE
49. NRX-A3 NUCLEAR TEST PLAN
ISSUED
50. INITIAL CRITICAL TEST SUMMARY
REPORT ISSUED
51. NRX-A1 SHIELD RADIATION #1332
ANALYSIS COMPLETE FOR
DESIGN RELEASE
52. KIWI-B5 ZERO POWER SHIELD TEST
ANALYSIS REPORT ISSUED
53. KIWI-B5A SHIELD TEST REPORT
ISSUED
54. NRX-A1 SHIELD RADIATION
ANALYSIS COMPLETE
55. FACILITY REQUIREMENTS #1333
REVIEW COMPLETE
56. START NRX REACTOR PROOF TEST

◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
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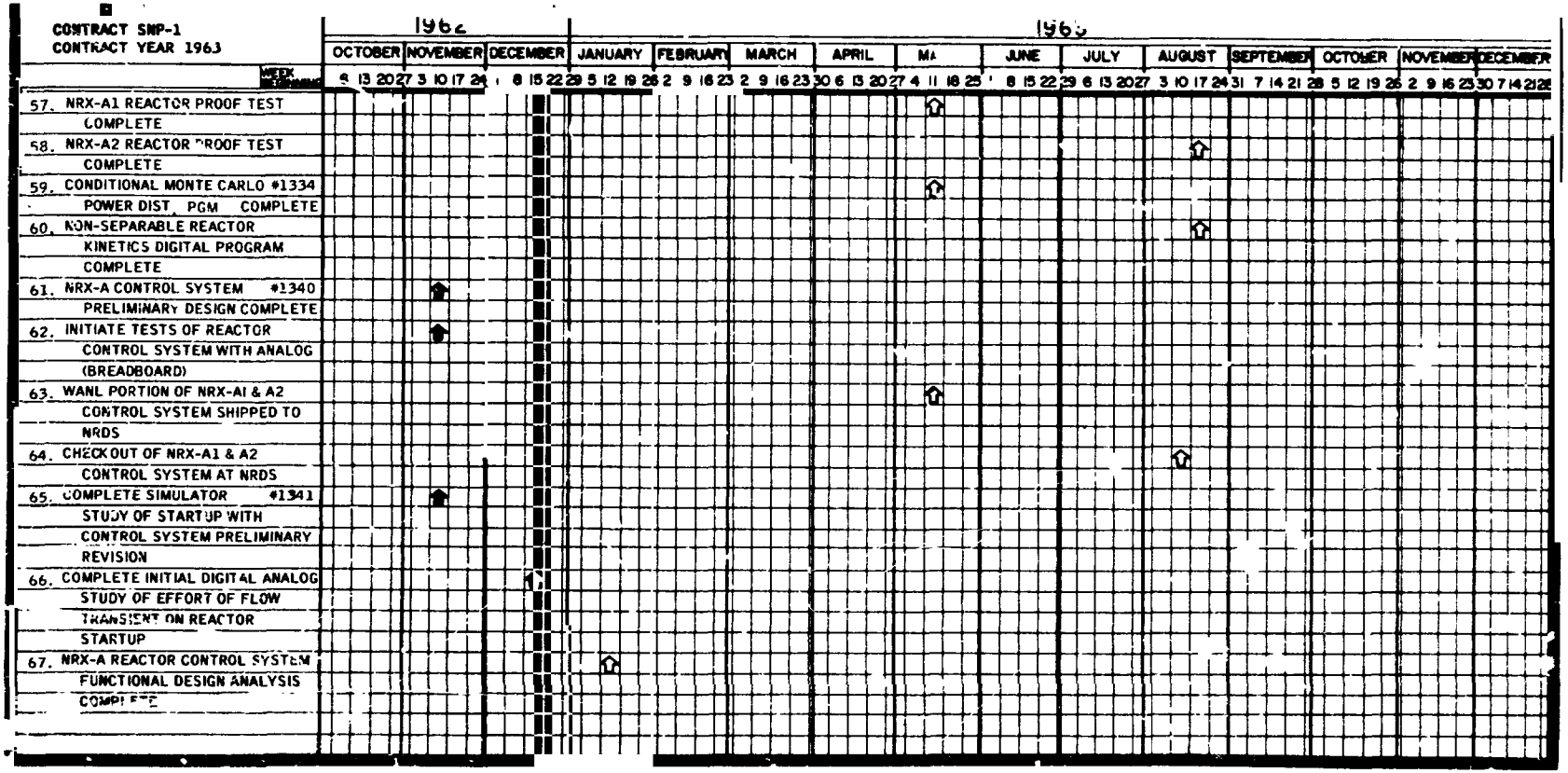
NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.3
NUCLEAR SUBSYSTEM (CONT'D)

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
9 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
57. NRX-A1 REACTOR PROOF TEST COMPLETE
58. NRX-A2 REACTOR PROOF TEST COMPLETE
59. CONDITIONAL MONTE CARLO #1334 POWER DIST. PGM COMPLETE
60. NON-SEPARABLE REACTOR KINETICS DIGITAL PROGRAM COMPLETE
61. NRX-A CONTROL SYSTEM #1340 PRELIMINARY DESIGN COMPLETE
62. INITIATE TESTS OF REACTOR CONTROL SYSTEM WITH ANALOG (BREADBOARD)
63. WANL PORTION OF NRX-A1 & A2 CONTROL SYSTEM SHIPPED TO NRDS
64. CHECKOUT OF NRX-A1 & A2 CONTROL SYSTEM AT NRDS
65. COMPLETE SIMULATOR #1341 STUDY OF STARTUP WITH CONTROL SYSTEM PRELIMINARY REVISION
66. COMPLETE INITIAL DIGITAL ANALOG STUDY OF EFFORT OF FLOW TRANSIENT ON REACTOR STARTUP
67. NRX-A REACTOR CONTROL SYSTEM FUNCTIONAL DESIGN ANALYSIS COMPLETE

⇧ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
⬆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
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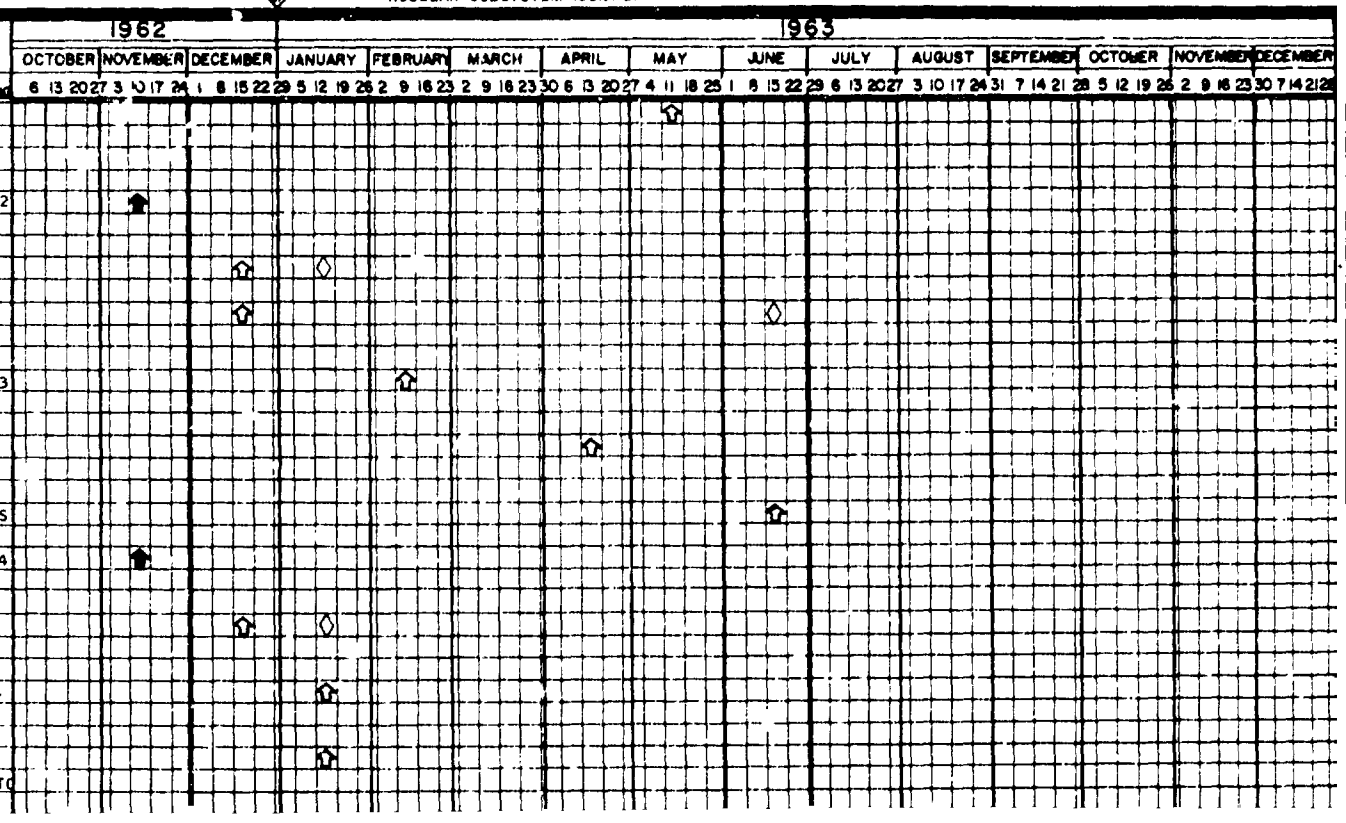
NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.3
NUCLEAR SUBSYSTEM (CONT'D)

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
68. NRX-A1 & A2 ANALYSIS OF CONTROL SYSTEM PERFORMANCE DURING REACTOR STARTUP COMPLETE
69. ISSUE SPECIFICATIONS #1342 FOR HYDRAULIC ACTUATORS FOR NRX SERIES
70. SELECT PNEUMATIC ACTUATOR DESIGN
71. SELECT CANDIDATE ELECTRO-MECHANICAL ACTUATOR FOR DEVELOPMENT
72. SINGLE PASSAGE TRANS- #1343 IENT FLOW EXPERIMENTS WITH NO HEATING COMPLETE
73. INITIAL SINGLE PASSAGE TRANS-IENT FLOW EXPERIMENTS WITH HEATING COMPLETE
74. INITIAL MULTIPLE PASSAGE TESTS WITH NO HEATING COMPLETE
75. SELECT TYPES OF #1344 NEUTRON DETECTORS FOR BLOCK I
76. SPECIFICATIONS FOR NRX-A NUCLEAR INSTRUMENTATION ISSUED
77. ESTABLISH DESIGN CHARACTERISTICS OF NEUTRON DETECTORS FOR BLOCK I ENGINE
78. ESTABLISH DESIGN CHARACT. OF THE INSTRUMENT AMPLIFIERS TO BE DEVL. FOR BLOCK I ENGINE

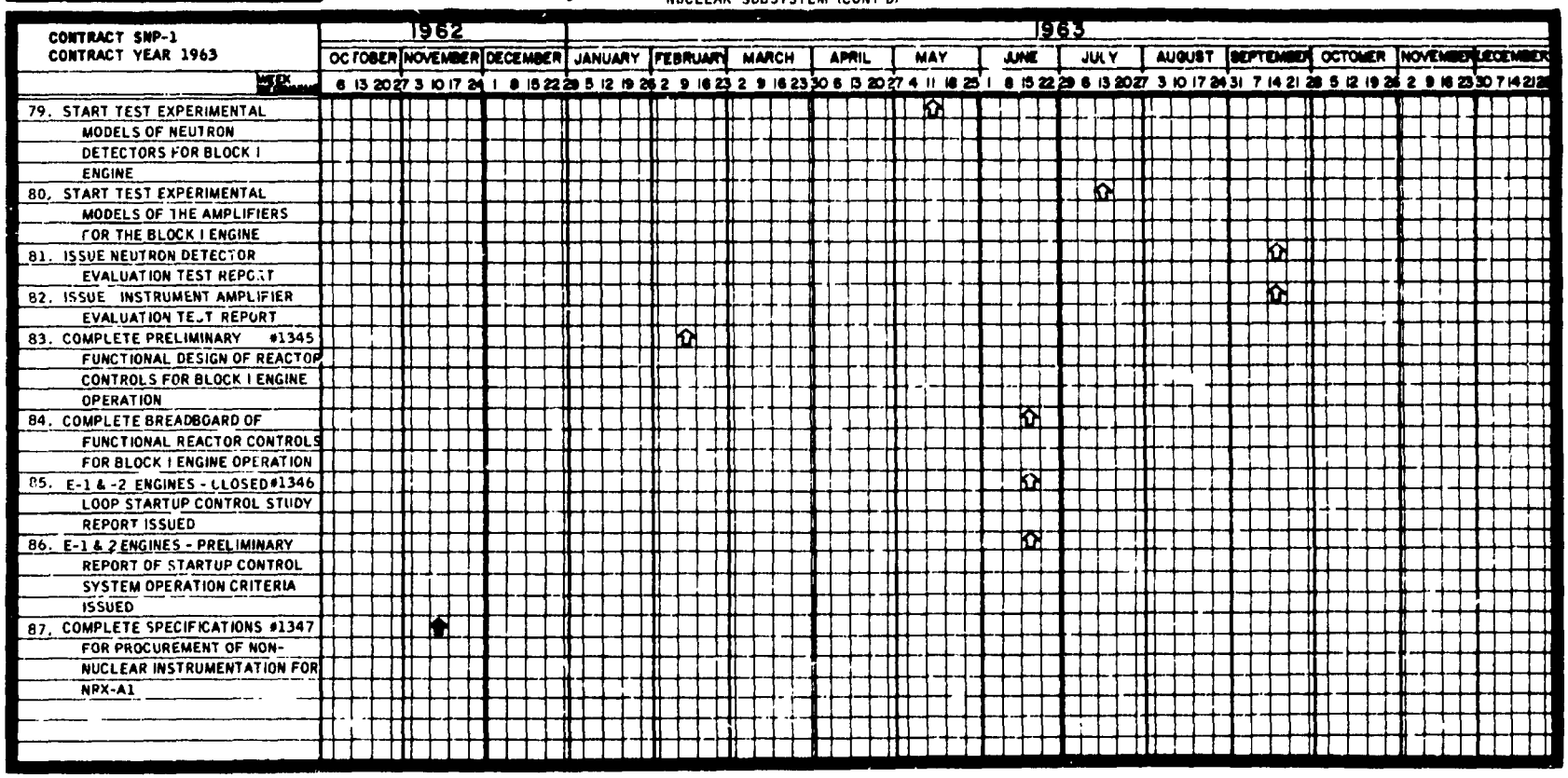
◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 10 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.3
NUCLEAR SUBSYSTEM (CONT'D)


CONTRACT SNP-1
CONTRACT YEAR 1963
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21
79. START TEST EXPERIMENTAL MODELS OF NEUTRON DETECTORS FOR BLOCK I ENGINE
80. START TEST EXPERIMENTAL MODELS OF THE AMPLIFIERS FOR THE BLOCK I ENGINE
81. ISSUE NEUTRON DETECTOR EVALUATION TEST REPORT
82. ISSUE INSTRUMENT AMPLIFIER EVALUATION TEST REPORT
83. COMPLETE PRELIMINARY #1345 FUNCTIONAL DESIGN OF REACTOR CONTROLS FOR BLOCK I ENGINE OPERATION
84. COMPLETE BREADBOARD OF FUNCTIONAL REACTOR CONTROLS FOR BLOCK I ENGINE OPERATION
85. E-1 & -2 ENGINES - CLOSED#1346 LOOP STARTUP CONTROL STUDY REPORT ISSUED
86. E-1 & 2 ENGINES - PRELIMINARY REPORT OF STARTUP CONTROL SYSTEM OPERATION CRITERIA ISSUED
87. COMPLETE SPECIFICATIONS #1347 FOR PROCUREMENT OF NON-NUCLEAR INSTRUMENTATION FOR NRX-A1

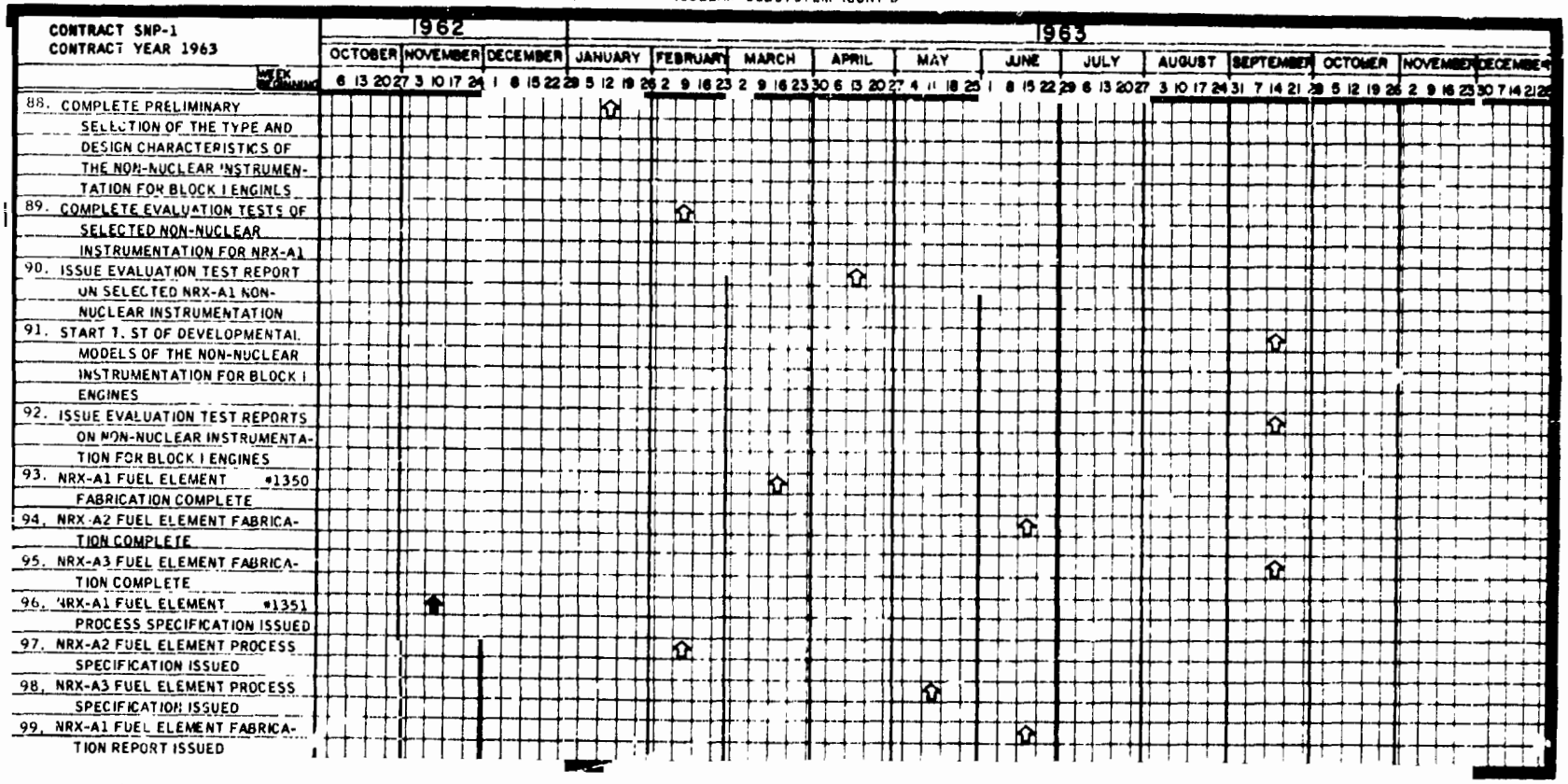
⇧ SCHEDULED MILESTUNE
◇ RESCHEDULED MILESTONE
⬆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHICVEMENT

REON

Figure 1
Sheet 11 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.3
NUCLEAR SUBSYSTEM (CONT'D)


CONTRACT SNP-1
CONTRACT YEAR 1963
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
88. COMPLETE PRELIMINARY SELECTION OF THE TYPE AND DESIGN CHARACTERISTICS OF THE NON-NUCLEAR INSTRUMENTATION FOR BLOCK I ENGINES
89. COMPLETE EVALUATION TESTS OF SELECTED NON-NUCLEAR INSTRUMENTATION FOR NRX-A1
90. ISSUE EVALUATION TEST REPORT ON SELECTED NRX-A1 NON-NUCLEAR INSTRUMENTATION
91. START 1. ST OF DEVELOPMENTAL MODELS OF THE NON-NUCLEAR INSTRUMENTATION FOR BLOCK I ENGINES
92. ISSUE EVALUATION TEST REPORTS ON NON-NUCLEAR INSTRUMENTATION FOR BLOCK I ENGINES
93. NRX-A1 FUEL ELEMENT #1350 FABRICATION COMPLETE
94. NRX-A2 FUEL ELEMENT FABRICATION COMPLETE
95. NRX-A3 FUEL ELEMENT FABRICATION COMPLETE
96. NRX-A1 FUEL ELEMENT #1351 PROCESS SPECIFICATION ISSUED
97. NRX-A2 FUEL ELEMENT PROCESS SPECIFICATION ISSUED
98. NRX-A3 FUEL ELEMENT PROCESS SPECIFICATION ISSUED
99. NRX-A1 FUEL ELEMENT FABRICATION REPORT ISSUED

◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

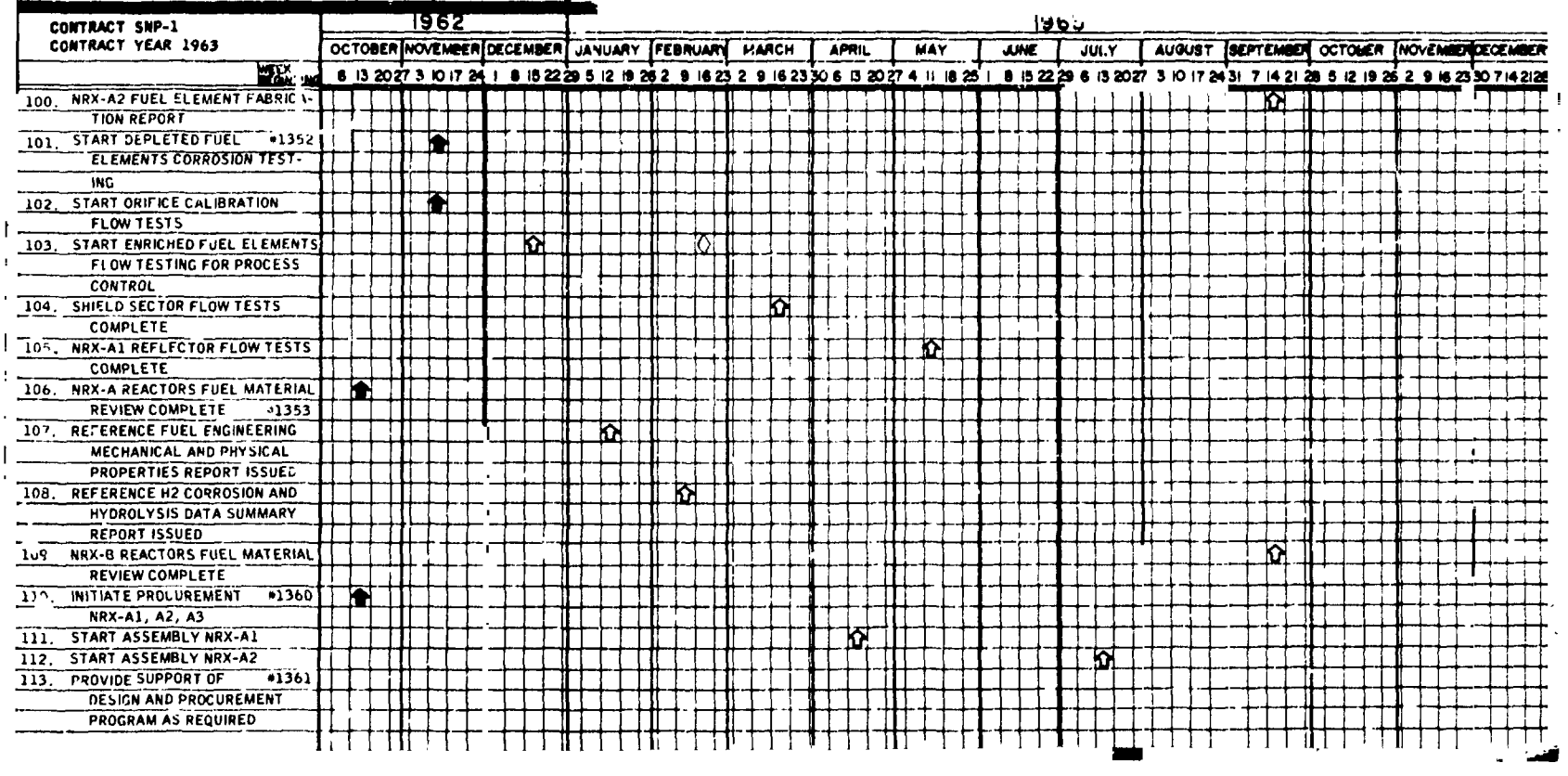
REON

Figure 1
Sheet 12 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.3
NUCLEAR SUBSYSTEM (CONT'D)

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK ENDING
100. NRX-A2 FUEL ELEMENT FABRICATION REPORT
101. START DEPLETED FUEL #1352 ELEMENTS CORROSION TESTING
102. START ORIFICE CALIBRATION FLOW TESTS
103. START ENRICHED FUEL ELEMENTS FLOW TESTING FOR PROCESS CONTROL
104. SHIELD SECTOR FLOW TESTS COMPLETE
105. NRX-A1 REFLECTOR FLOW TESTS COMPLETE
106. NRX-A REACTORS FUEL MATERIAL REVIEW COMPLETE #1353
107. REFERENCE FUEL ENGINEERING MECHANICAL AND PHYSICAL PROPERTIES REPORT ISSUED
108. REFERENCE H2 CORROSION AND HYDROLYSIS DATA SUMMARY REPORT ISSUED
109 NRX-B REACTORS FUEL MATERIAL REVIEW COMPLETE
110. INITIATE PROCUREMENT #1360 NRX-A1, A2, A3
111. START ASSEMBLY NRX-A1
112. START ASSEMBLY NRX-A2
113. PROVIDE SUPPORT OF #1361 DESIGN AND PROCUREMENT PROGRAM AS REQUIRED

⬠ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
⬟ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

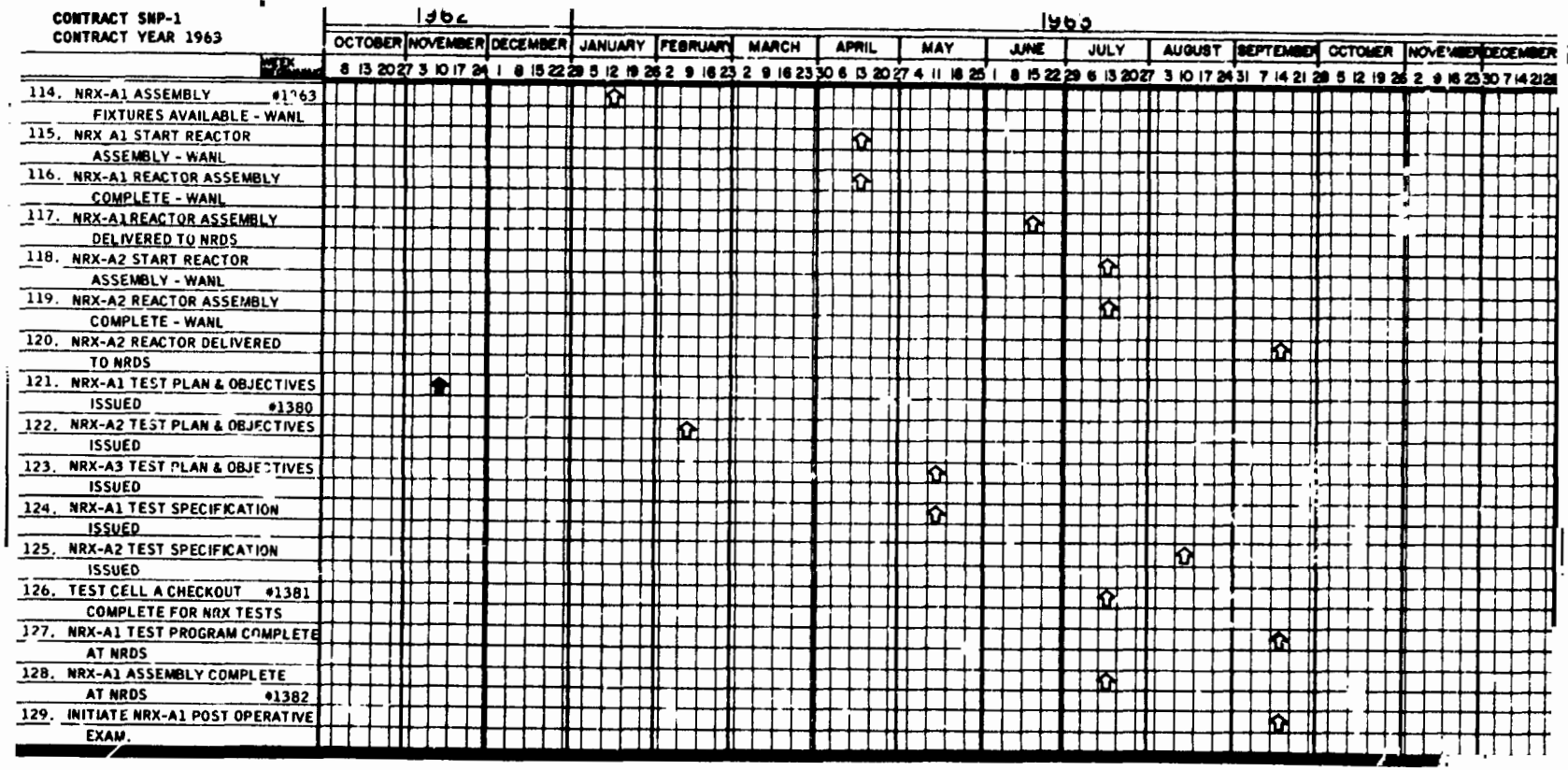
REON

Figure 1
Sheet 13 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.3
NUCLEAR SUBSYSTEM (CONT'D)

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
8 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
114. NRX-A1 ASSEMBLY #1363
FIXTURES AVAILABLE - WANL
115. NRX A1 START REACTOR ASSEMBLY - WANL
116. NRX-A1 REACTOR ASSEMBLY COMPLETE - WANL
117. NRX-A1 REACTOR ASSEMBLY DELIVERED TO NRDS
118. NRX-A2 START REACTOR ASSEMBLY - WANL
119. NRX-A2 REACTOR ASSEMBLY COMPLETE - WANL
120. NRX-A2 REACTOR DELIVERED TO NRDS
121. NRX-A1 TEST PLAN & OBJECTIVES ISSUED #1380
122. NRX-A2 TEST PLAN & OBJECTIVES ISSUED
123. NRX-A3 TEST PLAN & OBJECTIVES ISSUED
124. NRX-A1 TEST SPECIFICATION ISSUED
125. NRX-A2 TEST SPECIFICATION ISSUED
126. TEST CELL A CHECKOUT #1381 COMPLETE FOR NRX TESTS
127. NRX-A1 TEST PROGRAM COMPLETE AT NRDS
128. NRX-A1 ASSEMBLY COMPLETE AT NRDS #1382
129. INITIATE NRX-A1 POST OPERATIVE EXAM.

⇧ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
⬆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
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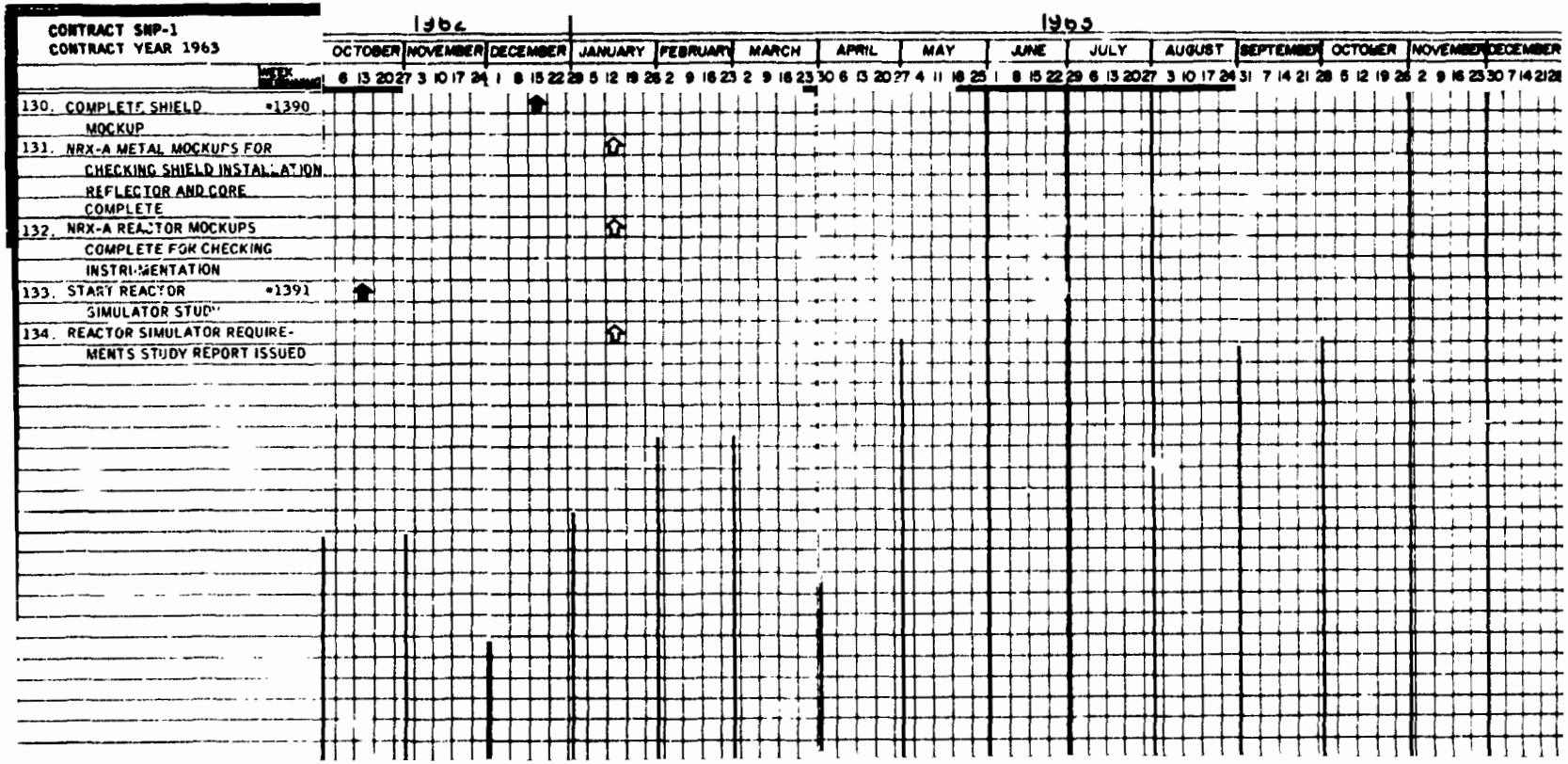
NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.3
NUCLEAR SUBSYSTEM (CONT'D)

CONTRACT SNP-1
CONTRACT YEAR 1963



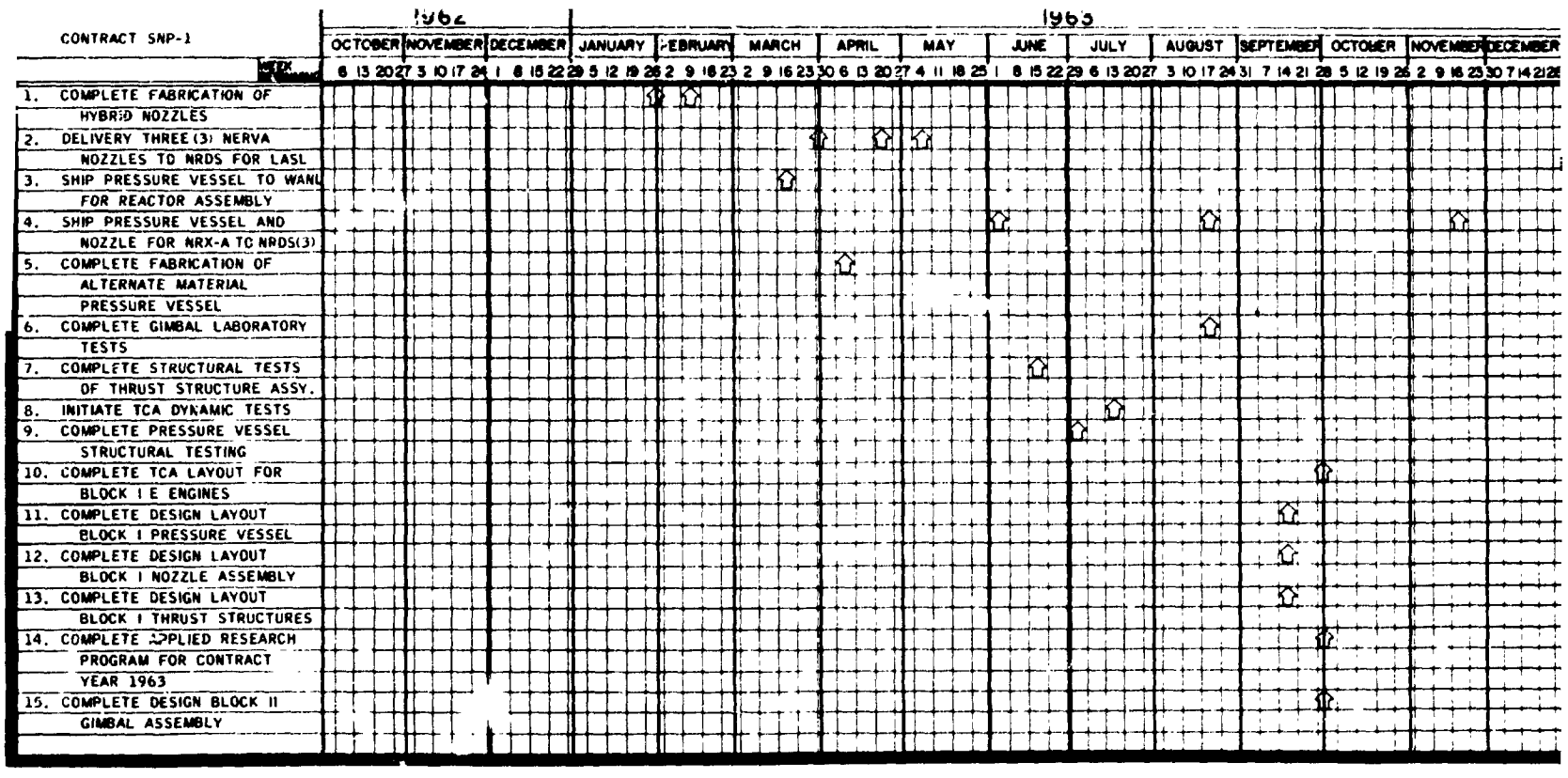
◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 15 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.4
THRUST CHAMBER ASSEMBLY

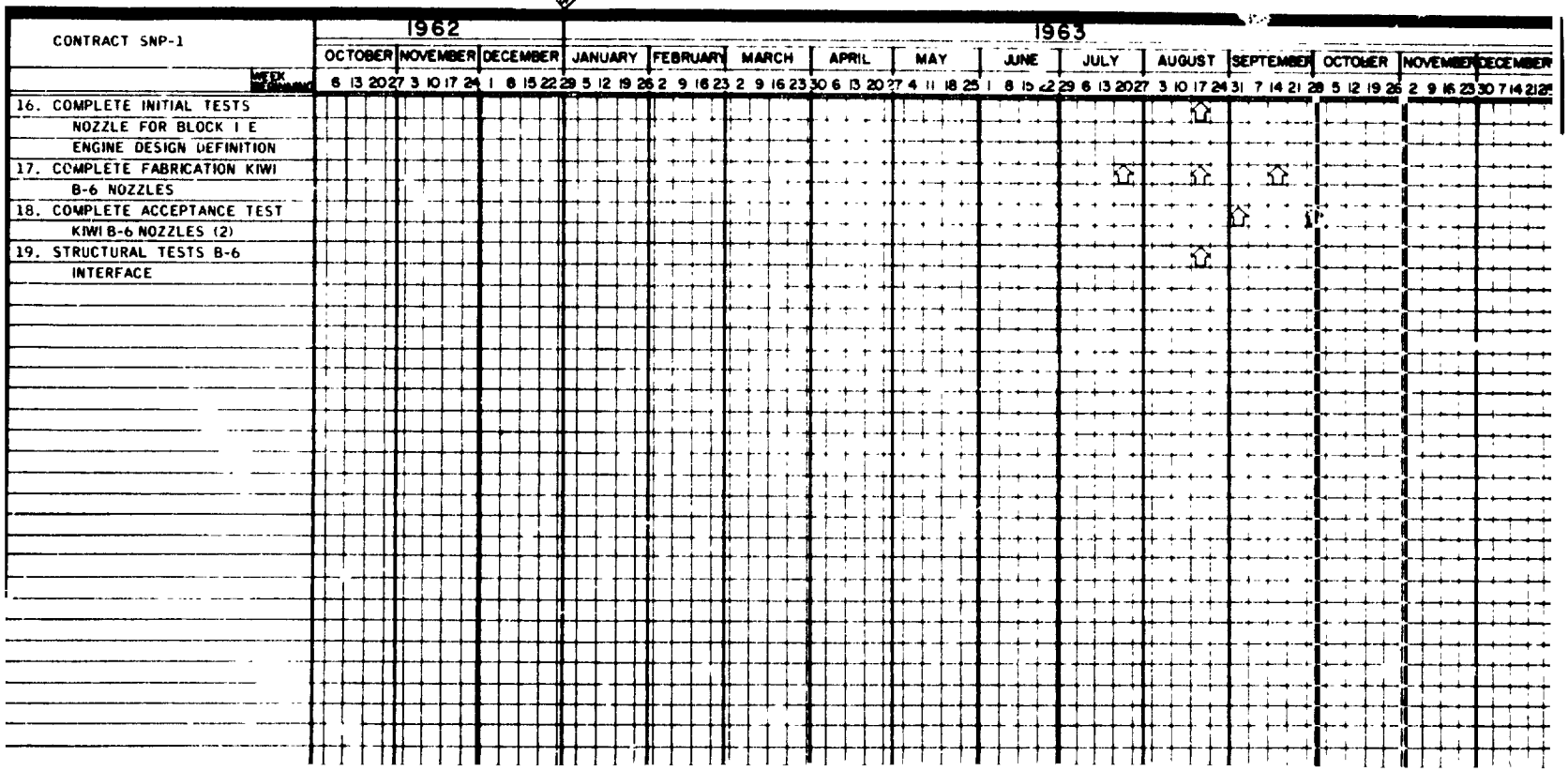

CONTRACT SNP-1
1962
1963
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
1. COMPLETE FABRICATION OF HYBRID NOZZLES
2. DELIVERY THREE (3) NERVA NOZZLES TO NRDS FOR LASL
3. SHIP PRESSURE VESSEL TO WANL FOR REACTOR ASSEMBLY
4. SHIP PRESSURE VESSEL AND NOZZLE FOR NRX-A TO NRDS(3)
5. COMPLETE FABRICATION OF ALTERNATE MATERIAL PRESSURE VESSEL
6. COMPLETE GIMBAL LABORATORY TESTS
7. COMPLETE STRUCTURAL TESTS OF THRUST STRUCTURE ASSY.
8. INITIATE TCA DYNAMIC TESTS
9. COMPLETE PRESSURE VESSEL STRUCTURAL TESTING
10. COMPLETE TCA LAYOUT FOR BLOCK I E ENGINES
11. COMPLETE DESIGN LAYOUT BLOCK I PRESSURE VESSEL
12. COMPLETE DESIGN LAYOUT BLOCK I NOZZLE ASSEMBLY
13. COMPLETE DESIGN LAYOUT BLOCK I THRUST STRUCTURES
14. COMPLETE APPLIED RESEARCH PROGRAM FOR CONTRACT YEAR 1963
15. COMPLETE DESIGN BLOCK II GIMBAL ASSEMBLY

⇧ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
⬆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.4
THRUST CHAMBER ASSEMBLY


CONTRACT SNP-1
1962
1963
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
16. COMPLETE INITIAL TESTS
NOZZLE FOR BLOCK I E
ENGINE DESIGN DEFINITION
17. COMPLETE FABRICATION KIWI
B-6 NOZZLES
18. COMPLETE ACCEPTANCE TEST
KIWI B-6 NOZZLES (2)
19. STRUCTURAL TESTS B-6
INTERFACE

SCHEDULED MILESTONE
RESCHEDULED MILESTONE
MILESTONE ACHIEVEMENT
RESCHEDULED MILESTONE ACHIEVEMENT

Figure 1
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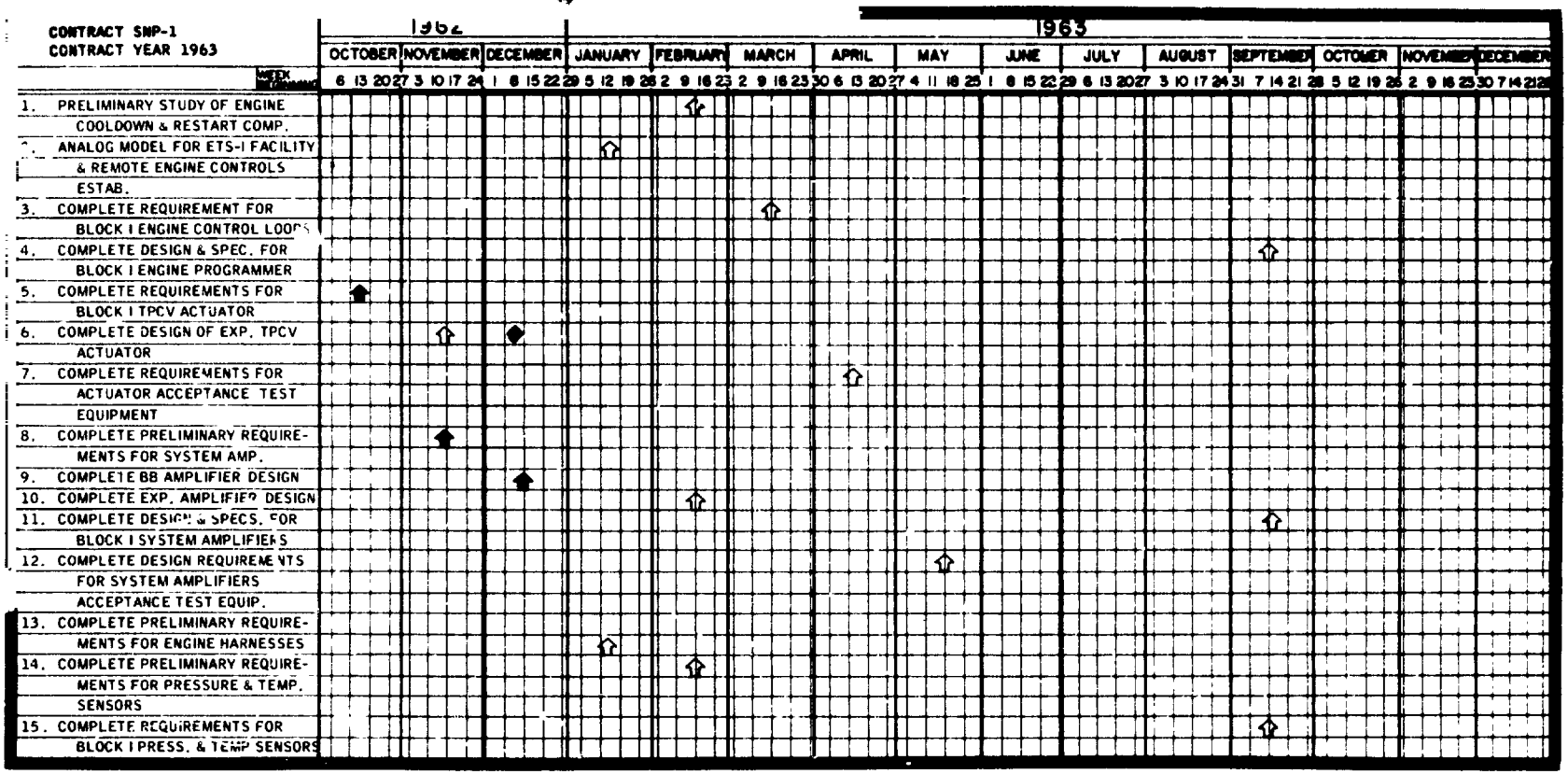
REON

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.5
ENGINE CONTROLS

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
1. PRELIMINARY STUDY OF ENGINE COOLDOWN & RESTART COMP.
2. ANALOG MODEL FOR ETS-I FACILITY & REMOTE ENGINE CONTROLS ESTAB.
3. COMPLETE REQUIREMENT FOR BLOCK I ENGINE CONTROL LOOPS
4. COMPLETE DESIGN & SPEC. FOR BLOCK I ENGINE PROGRAMMER
5. COMPLETE REQUIREMENTS FOR BLOCK I TPCV ACTUATOR
6. COMPLETE DESIGN OF EXP. TPCV ACTUATOR
7. COMPLETE REQUIREMENTS FOR ACTUATOR ACCEPTANCE TEST EQUIPMENT
8. COMPLETE PRELIMINARY REQUIREMENTS FOR SYSTEM AMP.
9. COMPLETE BB AMPLIFIER DESIGN
10. COMPLETE EXP. AMPLIFIER DESIGN
11. COMPLETE DESIGN & SPECS. FOR BLOCK I SYSTEM AMPLIFIERS
12. COMPLETE DESIGN REQUIREMENTS FOR SYSTEM AMPLIFIERS ACCEPTANCE TEST EQUIP.
13. COMPLETE PRELIMINARY REQUIREMENTS FOR ENGINE HARNESSES
14. COMPLETE PRELIMINARY REQUIREMENTS FOR PRESSURE & TEMP. SENSORS
15. COMPLETE REQUIREMENTS FOR BLOCK I PRESS. & TEMP SENSORS

◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

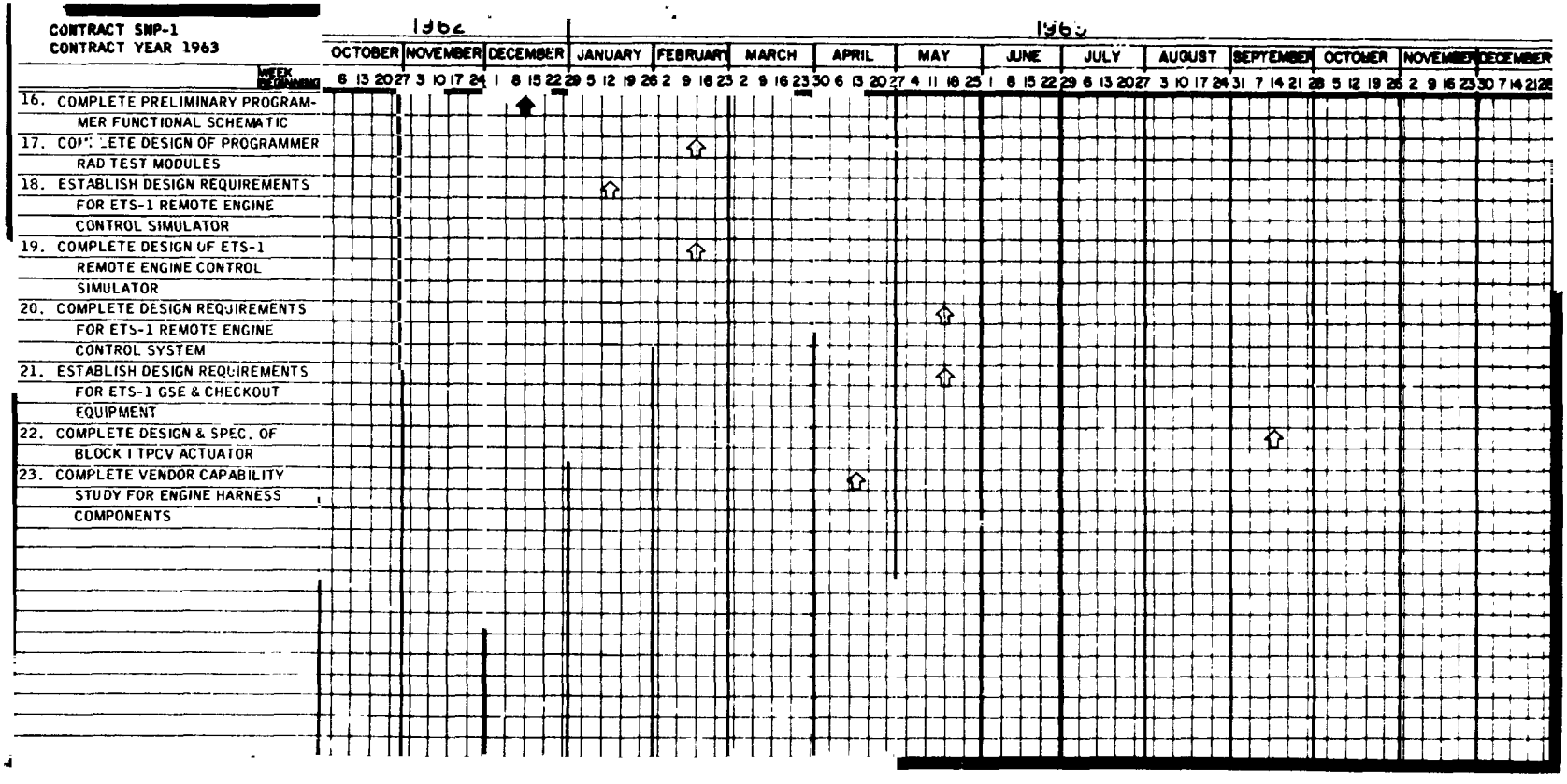
REON

Figure 1
Sheet 18 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.5
ENGINE CONTROLS (CONT'D)

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
16. COMPLETE PRELIMINARY PROGRAMMER FUNCTIONAL SCHEMATIC
17. COMPLETE DESIGN OF PROGRAMMER RAD TEST MODULES
18. ESTABLISH DESIGN REQUIREMENTS FOR ETS-1 REMOTE ENGINE CONTROL SIMULATOR
19. COMPLETE DESIGN OF ETS-1 REMOTE ENGINE CONTROL SIMULATOR
20. COMPLETE DESIGN REQUIREMENTS FOR ETS-1 REMOTE ENGINE CONTROL SYSTEM
21. ESTABLISH DESIGN REQUIREMENTS FOR ETS-1 GSE & CHECKOUT EQUIPMENT
22. COMPLETE DESIGN & SPEC. OF BLOCK I TPCV ACTUATOR
23. COMPLETE VENDOR CAPABILITY STUDY FOR ENGINE HARNESS COMPONENTS

⇧ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
⬆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

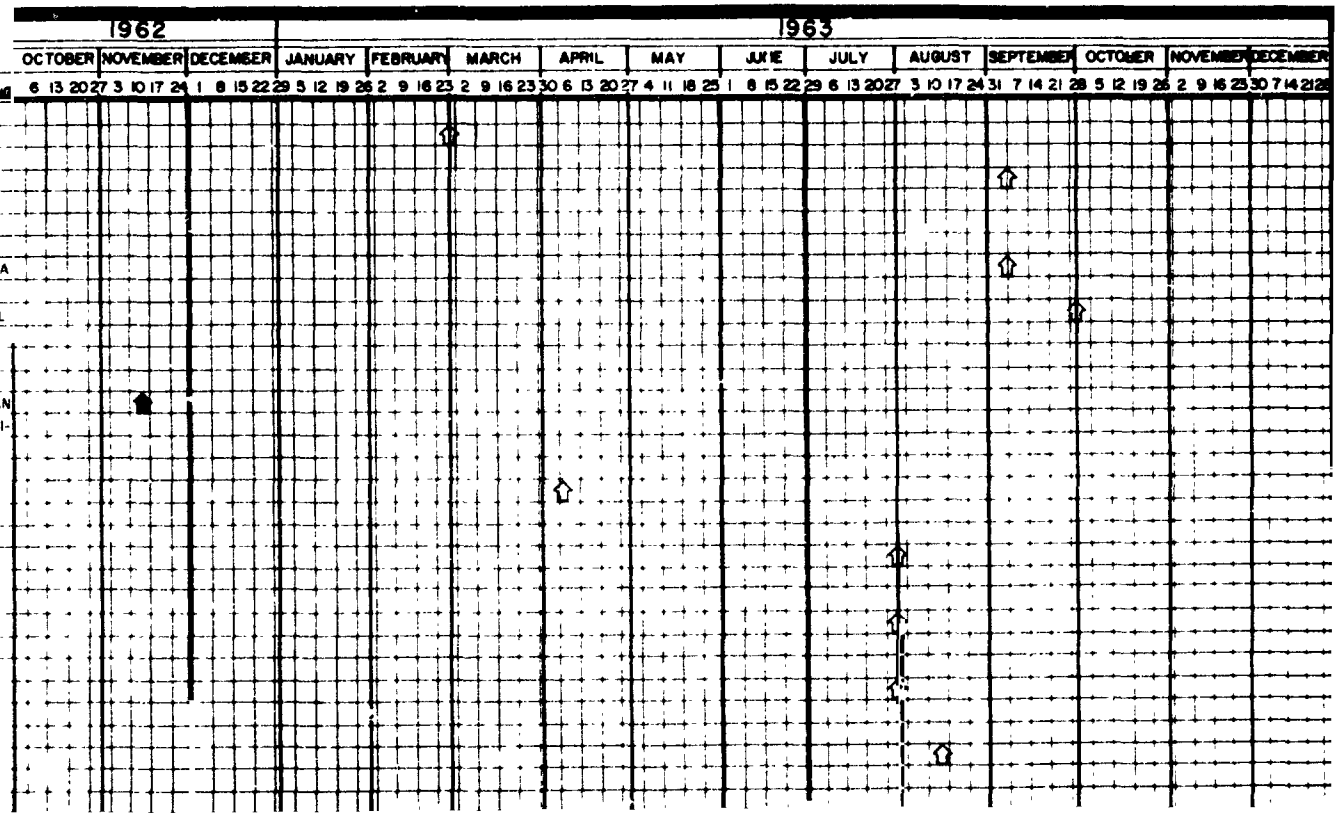
REON

Figure 1
Sheet 19 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.6
DESTRUCT SYSTEM

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
FRAGMENTATION EXPERIMENTS
1 COMPLETE FUNDAMENTAL FRAG - MENTATION RESEARCH
2. COMPLETE BASIC FRAGMENTATION RESEARCH ON FUNDAMENTAL COMBINATIONS OF EXP'L DESTRUCT SYSTEMS
3. COMPLETE ADDITIONAL FRAGMENTA TION RESEARCH AS REQUIRED
4 PUBLISH REPORT OF FUNDAMENTAL CORRELATION EXPERIMENTS
RADIATION EFFECTS EXPERIMENTS
5 PREPARE & PUBLISH PROGRAM PLAN FOR RADIATION EFFECTS EXPERI- MENTS ON EXPLOSIVES & INITIATORS
6. COMPLETE INITIAL RADIATION EFFECTS EXPERIMENTS ON EXPLOSIVES
7. COMPLETE INITIAL R E. EXP'RI- MENTS ON EXPLOSIVES AT HIGH AND LOW TEMPERATURE
8. C. MPLETE INITIAL RADIATION EFFECTS EXPERIMENTS ON INITIATORS
9. COMPLETE INITIAL REVIEW OF PICATINNY RADIAT'ON EFFECTS EXPERIMENTS
10. COMPLETE REVIEW & COMPARE ALL EXPLOSIVE RADIATION EFFECT WORK

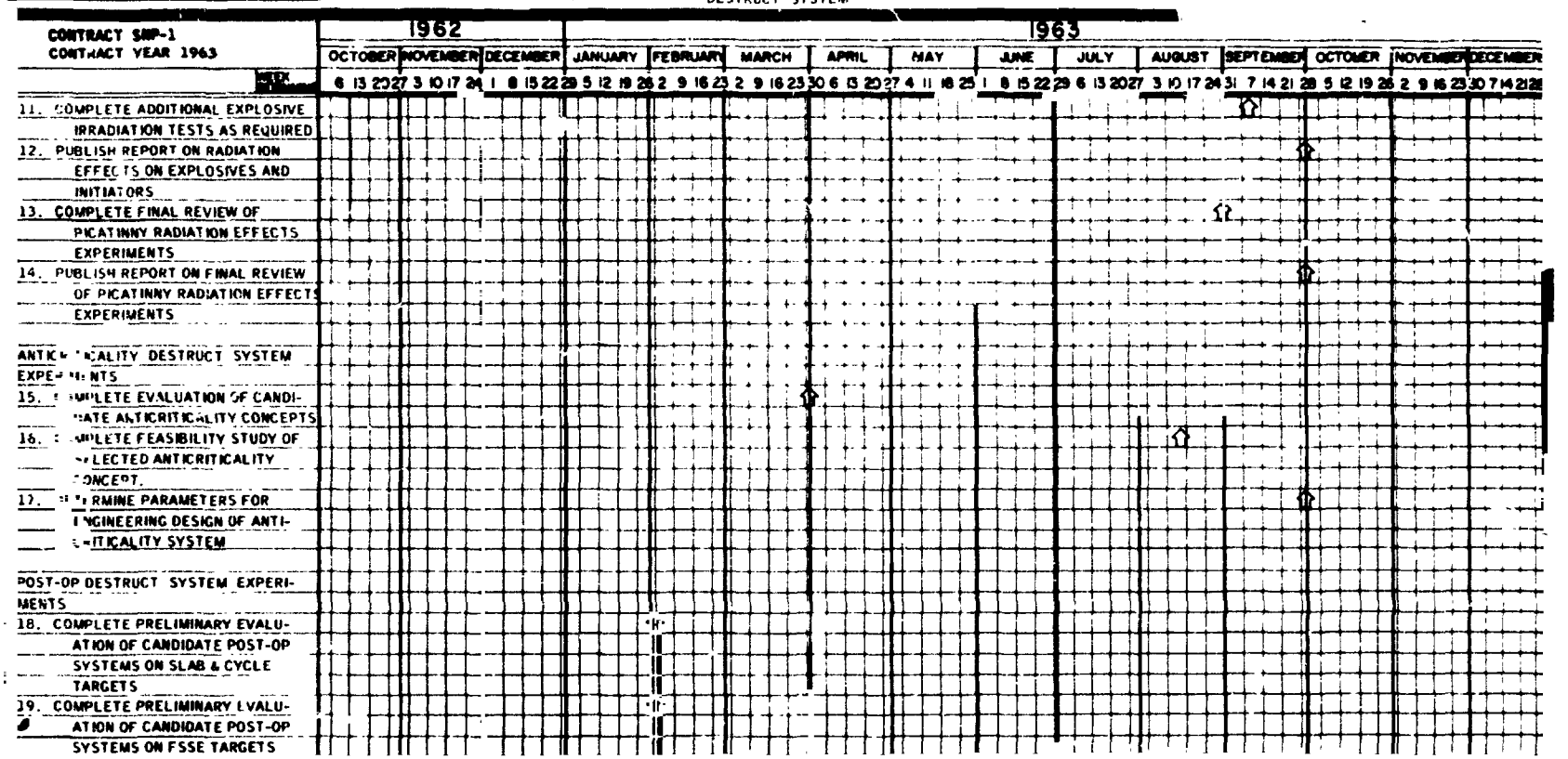
◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 20 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1 6
DESTRUCT SYSTEM


CONTRACT SNP-1
CONTRACT YEAR 1963
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
11. COMPLETE ADDITIONAL EXPLOSIVE IRRADIATION TESTS AS REQUIRED
12. PUBLISH REPORT ON RADIATION EFFECTS ON EXPLOSIVES AND INITIATORS
13. COMPLETE FINAL REVIEW OF PICATINNY RADIATION EFFECTS EXPERIMENTS
14. PUBLISH REPORT ON FINAL REVIEW OF PICATINNY RADIATION EFFECTS EXPERIMENTS
ANTICRITICALITY DESTRUCT SYSTEM EXPERIMENTS
15. COMPLETE EVALUATION OF CANDIDATE ANTICRITICALITY CONCEPTS
16. COMPLETE FEASIBILITY STUDY OF SELECTED ANTICRITICALITY CONCEPT
17. DETERMINE PARAMETERS FOR ENGINEERING DESIGN OF ANTICRITICALITY SYSTEM
POST-OP DESTRUCT SYSTEM EXPERIMENTS
18. COMPLETE PRELIMINARY EVALUATION OF CANDIDATE POST-OP SYSTEMS ON SLAB & CYCLE TARGETS
19. COMPLETE PRELIMINARY EVALUATION OF CANDIDATE POST-OP SYSTEMS ON FSSE TARGETS

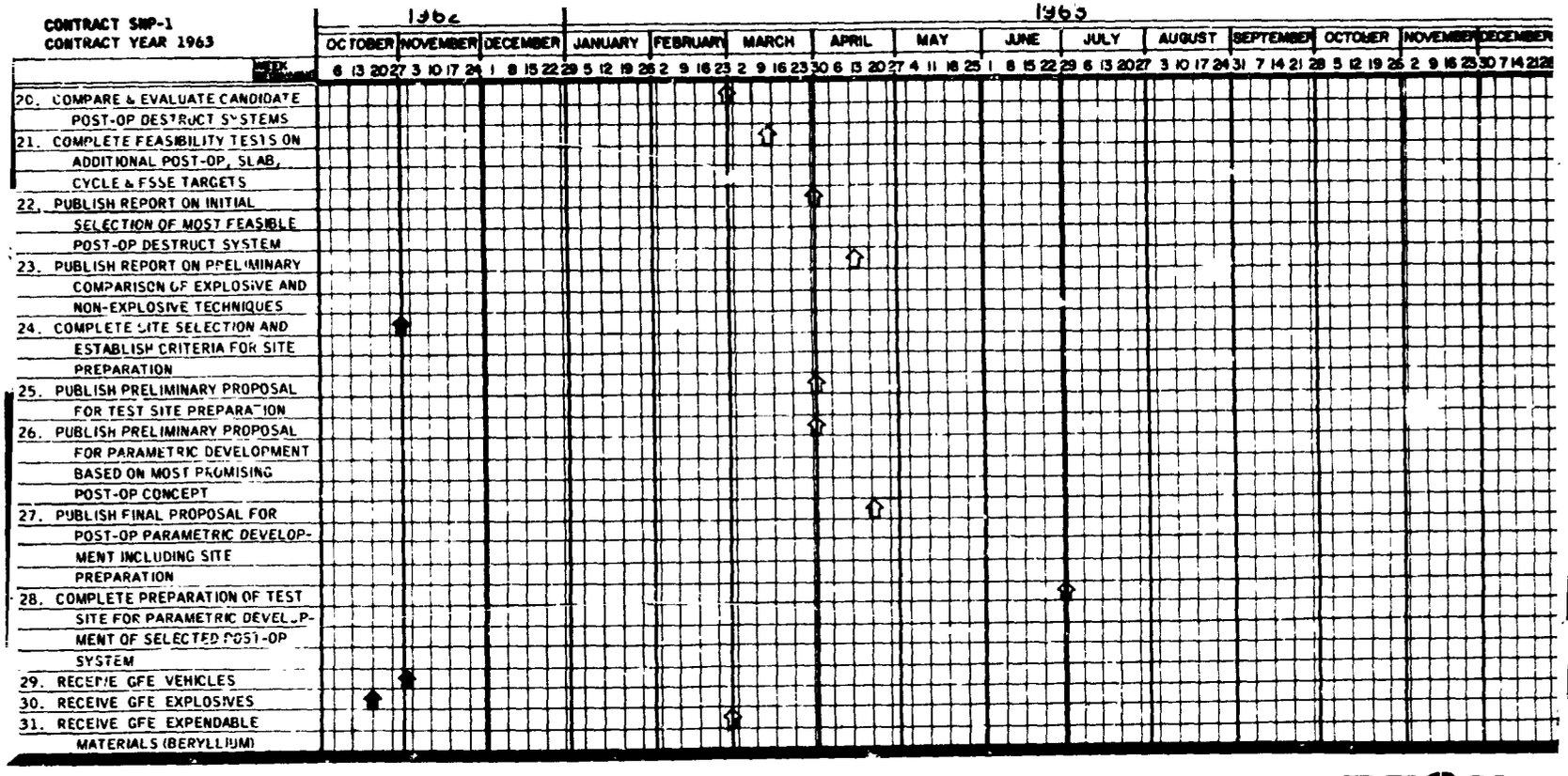
⇧ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
⬟ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 21 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.6
DESTRUCT SYSTEM


CONTRACT SNP-1
CONTRACT YEAR 1963
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
20. COMPARE & EVALUATE CANDIDATE POST-OP DESTRUCT SYSTEMS
21. COMPLETE FEASIBILITY TESTS ON ADDITIONAL POST-OP, SLAB, CYCLE & FSSE TARGETS
22. PUBLISH REPORT ON INITIAL SELECTION OF MOST FEASIBLE POST-OP DESTRUCT SYSTEM
23. PUBLISH REPORT ON PRELIMINARY COMPARISON OF EXPLOSIVE AND NON-EXPLOSIVE TECHNIQUES
24. COMPLETE SITE SELECTION AND ESTABLISH CRITERIA FOR SITE PREPARATION
25. PUBLISH PRELIMINARY PROPOSAL FOR TEST SITE PREPARATION
26. PUBLISH PRELIMINARY PROPOSAL FOR PARAMETRIC DEVELOPMENT BASED ON MOST PROMISING POST-OP CONCEPT
27. PUBLISH FINAL PROPOSAL FOR POST-OP PARAMETRIC DEVELOPMENT INCLUDING SITE PREPARATION
28. COMPLETE PREPARATION OF TEST SITE FOR PARAMETRIC DEVELOPMENT OF SELECTED POST-OP SYSTEM
29. RECEIVE GFE VEHICLES
30. RECEIVE GFE EXPLOSIVES
31. RECEIVE GFE EXPENDABLE MATERIALS (BERYLLIUM)

⇧ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
⬆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

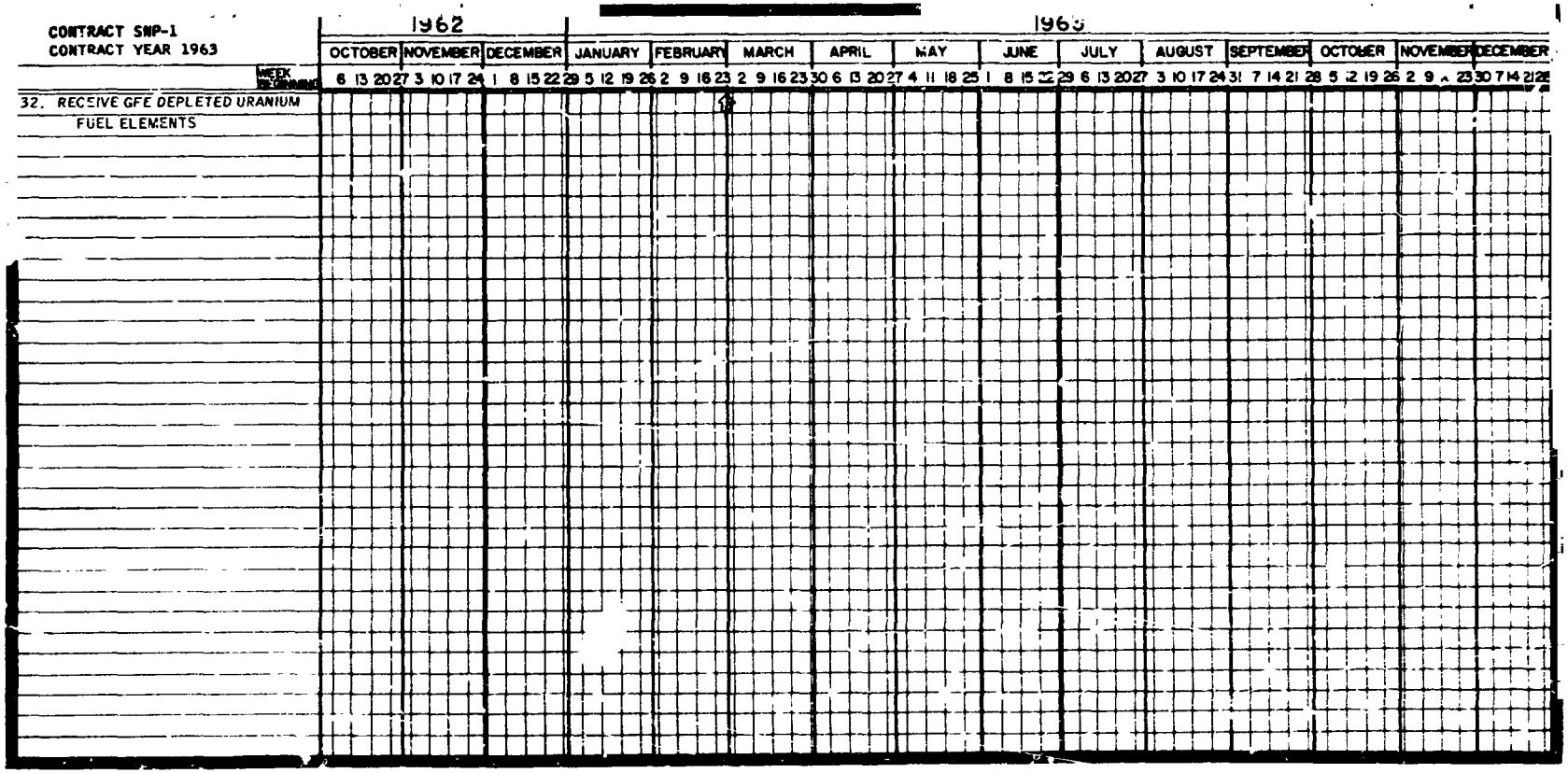
REON

Figure 1
Sheet 22 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.6
DESTRUCT SYSTEM

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 23 30 7 14 21 28
32. RECEIVE GFE DEPLETED URANIUM FUEL ELEMENTS

◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

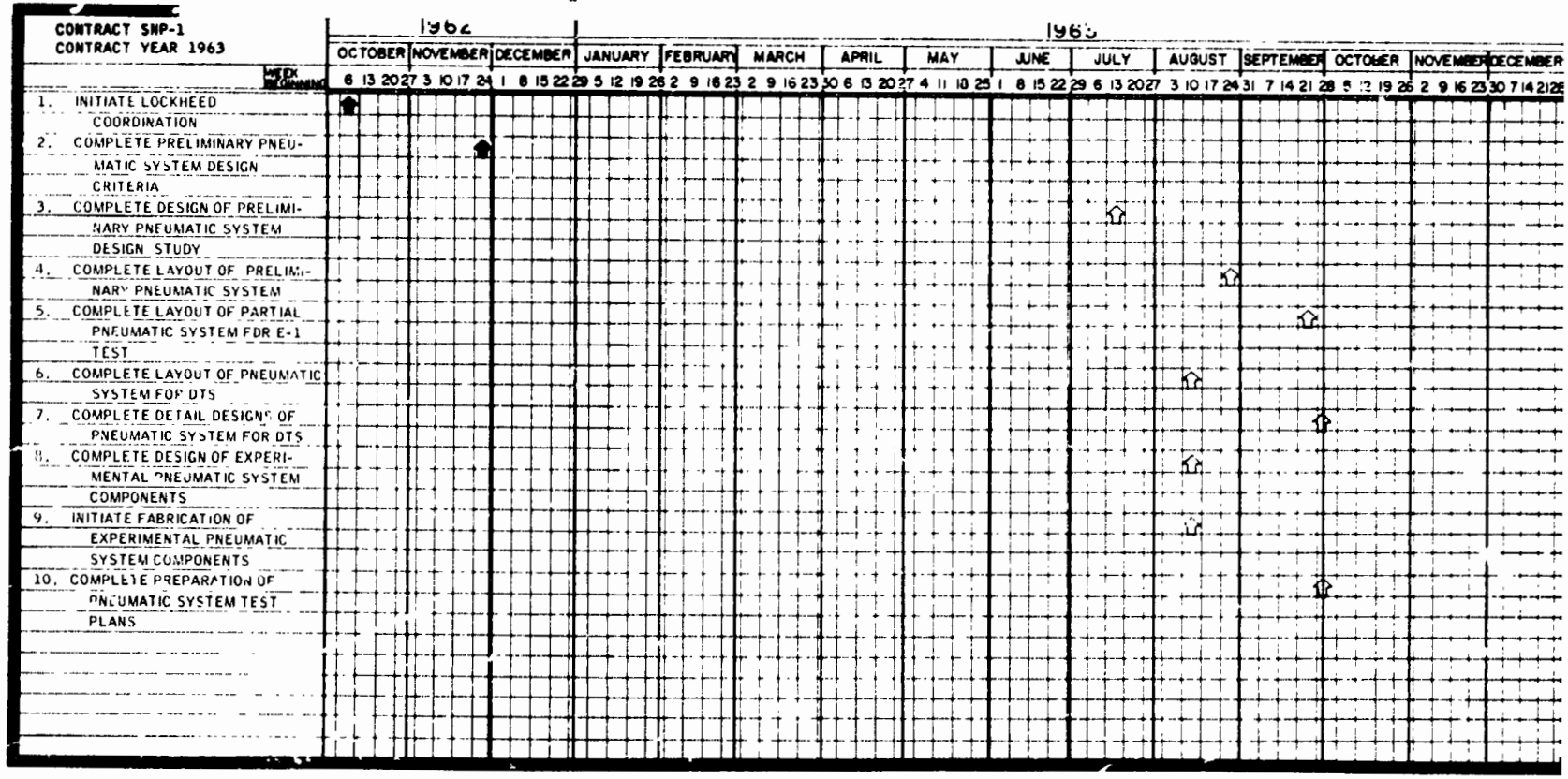
Figure 1
Sheet 23 of 54

CONFIDENTIAL

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.7
PNEUMATIC SYSTEM

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
1. INITIATE LOCKHEED COORDINATION
2. COMPLETE PRELIMINARY PNEUMATIC SYSTEM DESIGN CRITERIA
3. COMPLETE DESIGN OF PRELIMINARY PNEUMATIC SYSTEM DESIGN STUDY
4. COMPLETE LAYOUT OF PRELIMINARY PNEUMATIC SYSTEM
5. COMPLETE LAYOUT OF PARTIAL PNEUMATIC SYSTEM FOR E-1 TEST
6. COMPLETE LAYOUT OF PNEUMATIC SYSTEM FOR DTS
7. COMPLETE DETAIL DESIGN OF PNEUMATIC SYSTEM FOR DTS
8. COMPLETE DESIGN OF EXPERIMENTAL PNEUMATIC SYSTEM COMPONENTS
9. INITIATE FABRICATION OF EXPERIMENTAL PNEUMATIC SYSTEM COMPONENTS
10. COMPLETE PREPARATION OF PNEUMATIC SYSTEM TEST PLANS

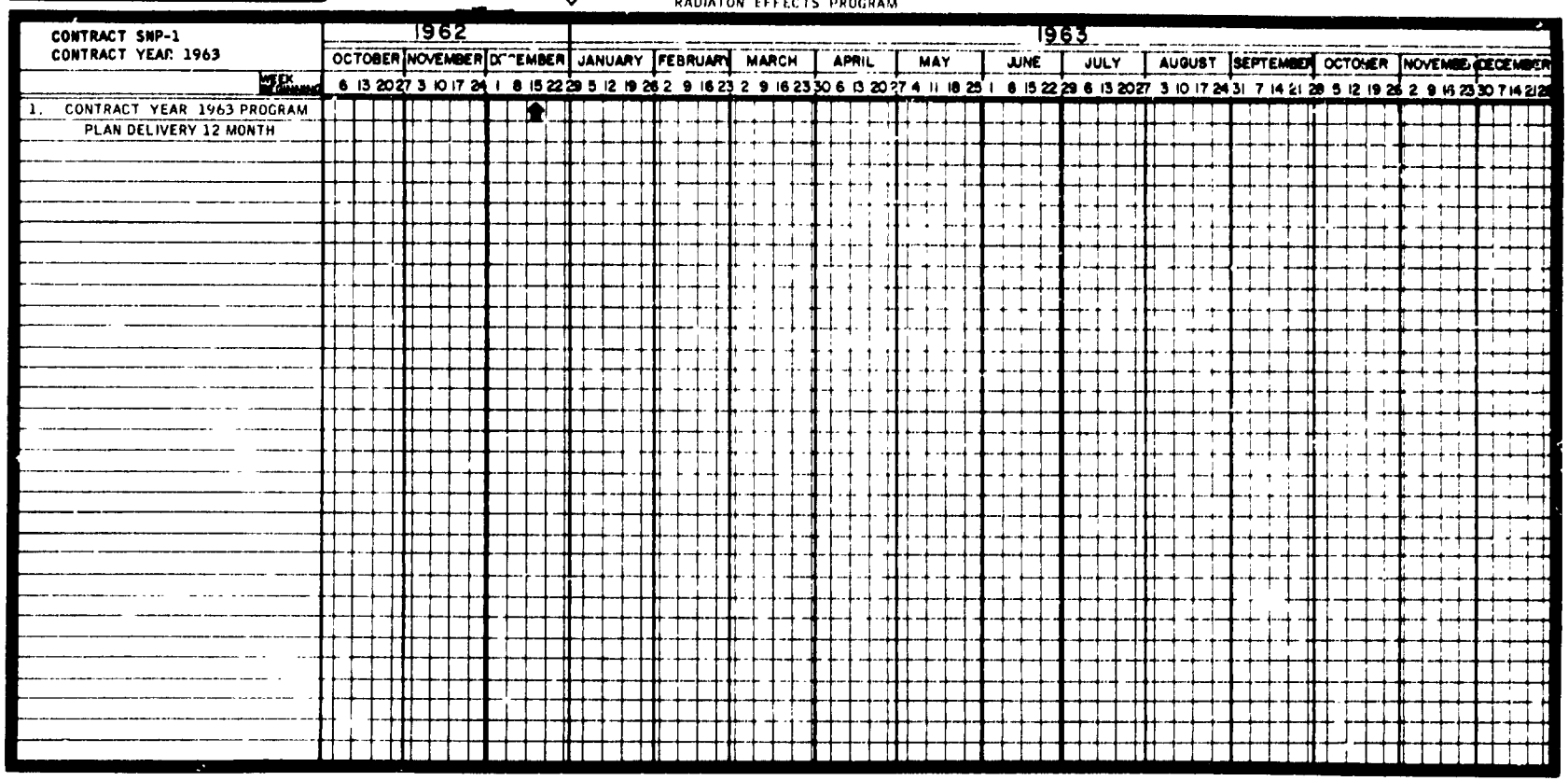
⇧ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
⬆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 24 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 1.9
RADIATON EFFECTS PROGRAM


CONTRACT SNP-1
CONTRACT YEAR 1963
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
1. CONTRACT YEAR 1963 PROGRAM
PLAN DELIVERY 12 MONTH

◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

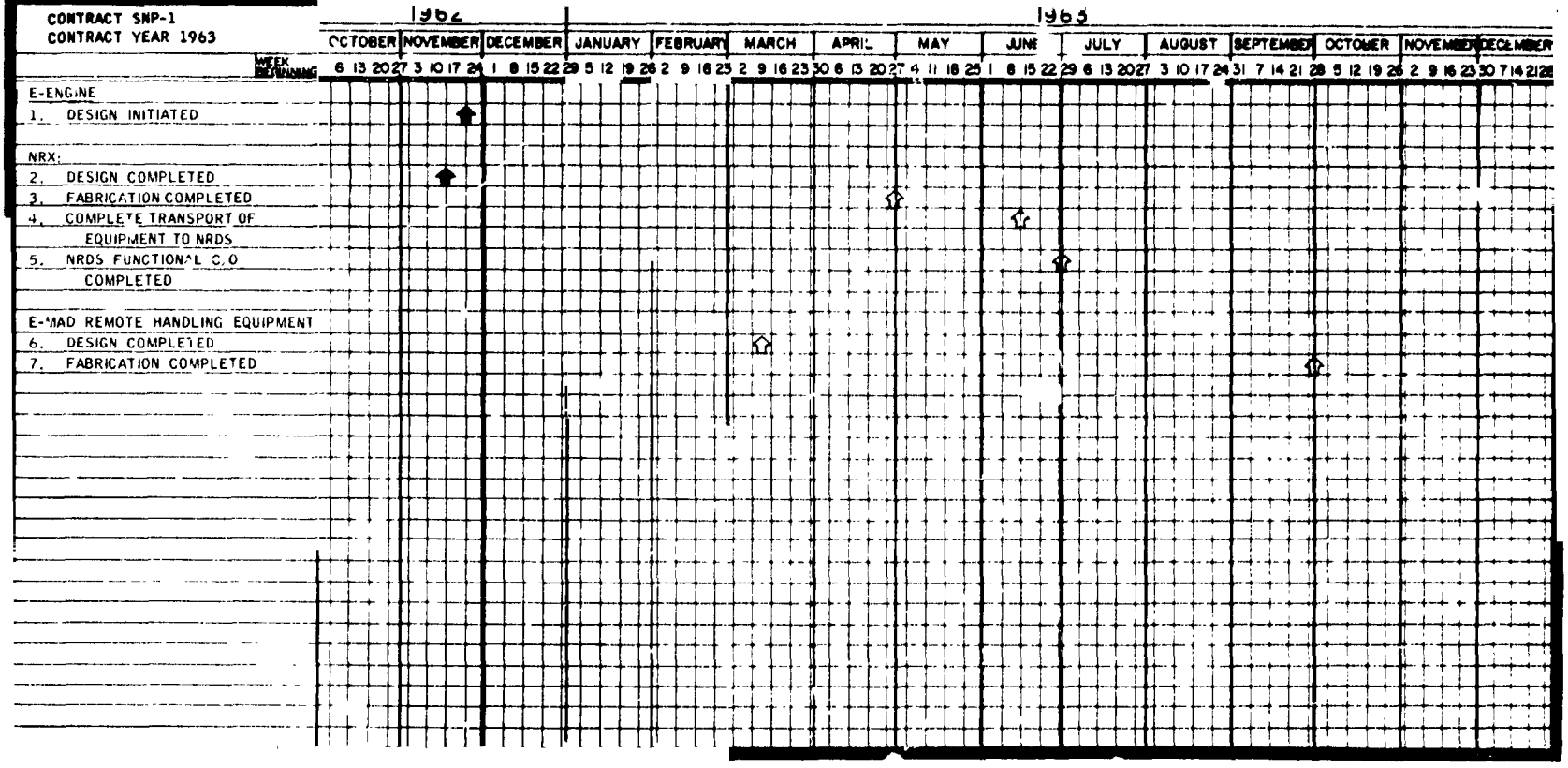
REON

Figure 1
Sheet 25 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 2.1
REMOTE HANDLING EQUIPMENT

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
E-ENGINE
1. DESIGN INITIATED
NRX:
2. DESIGN COMPLETED
3. FABRICATION COMPLETED
4. COMPLETE TRANSPORT OF EQUIPMENT TO NRDS
5. NRDS FUNCTIONAL C.O COMPLETED
E-MAD REMOTE HANDLING EQUIPMENT
6. DESIGN COMPLETED
7. FABRICATION COMPLETED

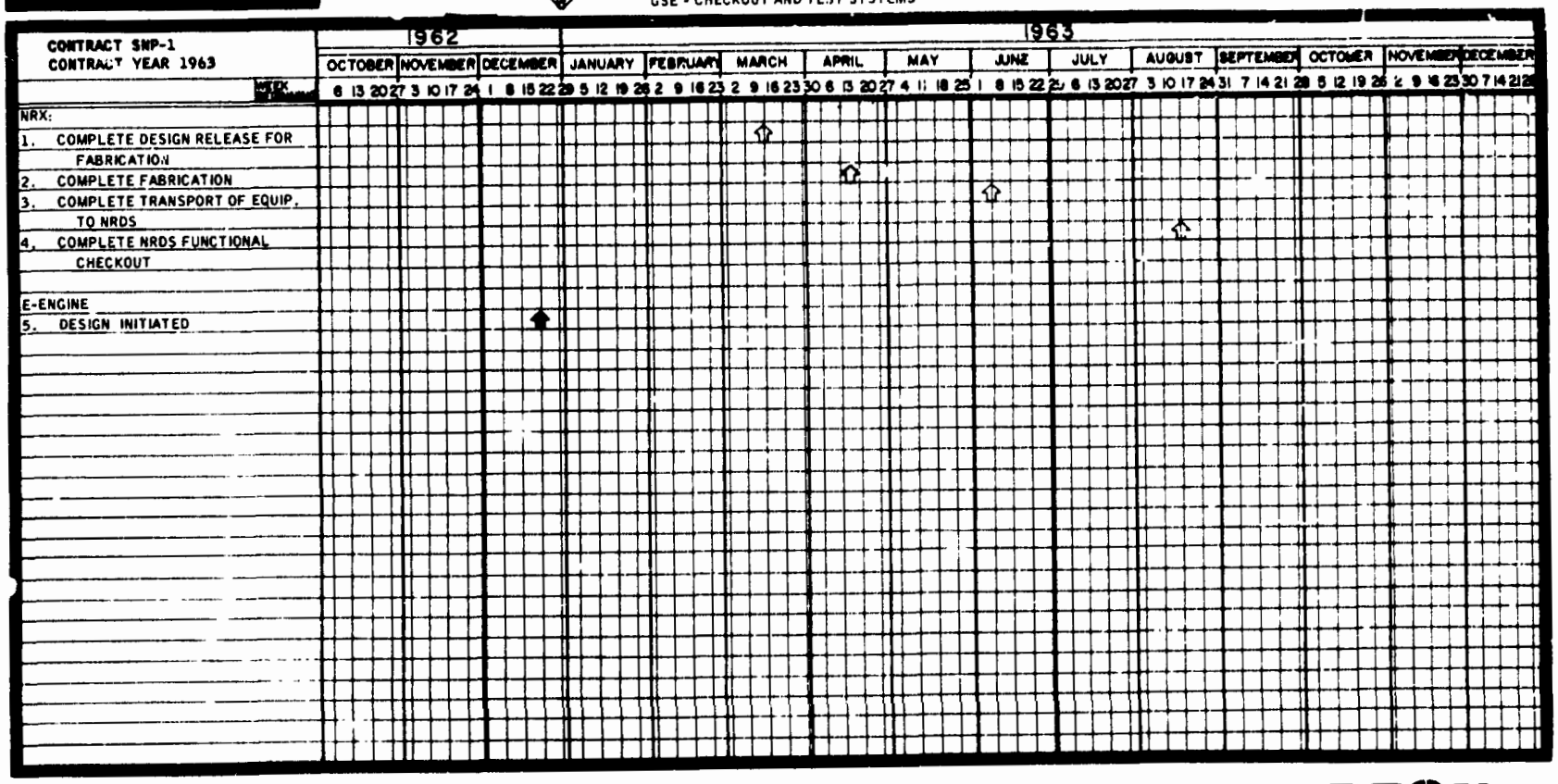
◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 26 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 2.2
GSE - CHECKOUT AND TEST SYSTEMS



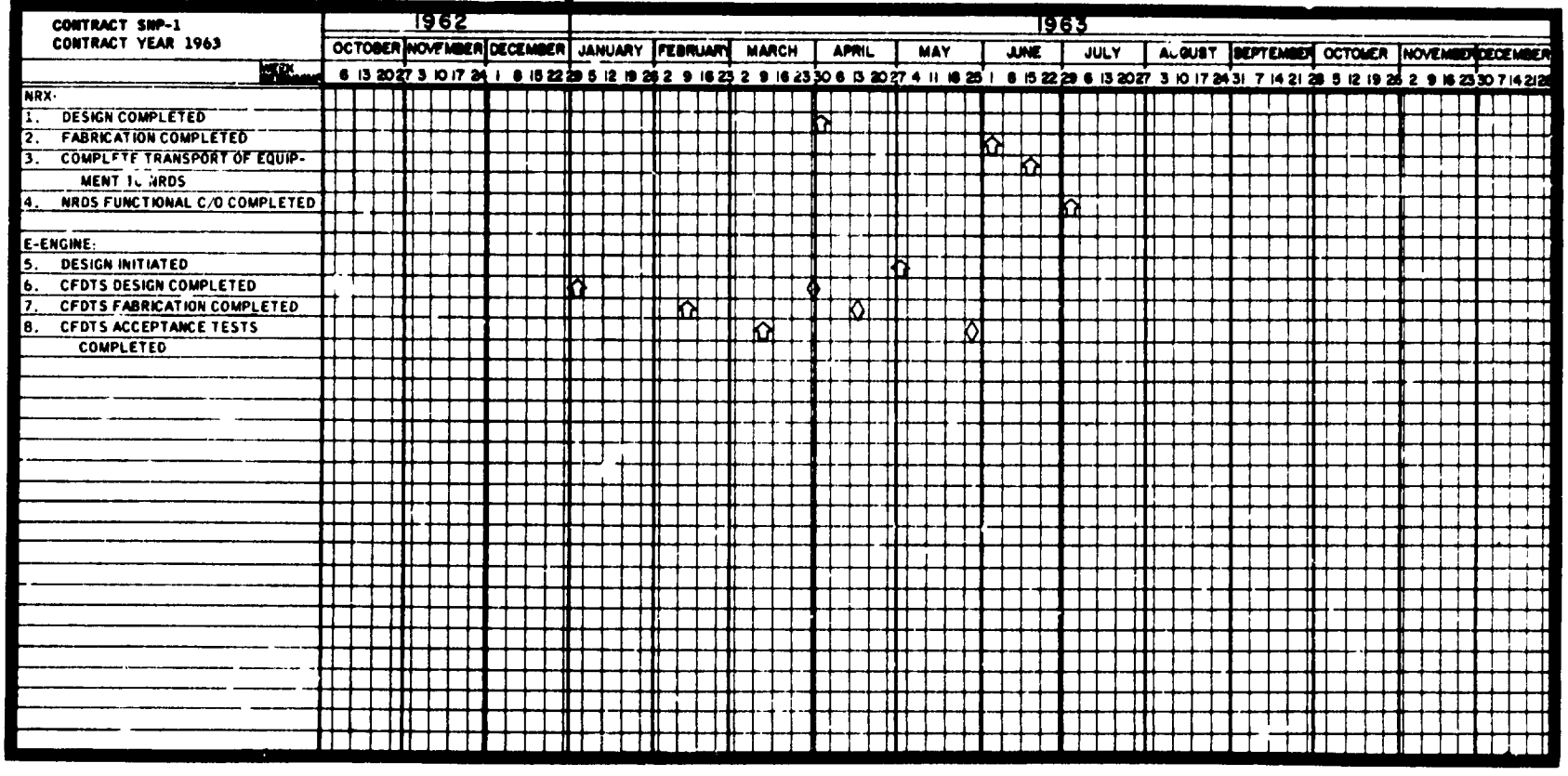
◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 27 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 2.3
GSE - HANDLING AND MAINTENANCE


CONTRACT SNP-1
CONTRACT YEAR 1963
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
NRX:
1. DESIGN COMPLETED
2. FABRICATION COMPLETED
3. COMPLETE TRANSPORT OF EQUIPMENT TO NRDS
4. NRDS FUNCTIONAL C/O COMPLETED
E-ENGINE:
5. DESIGN INITIATED
6. CFDTS DESIGN COMPLETED
7. CFDTS FABRICATION COMPLETED
8. CFDTS ACCEPTANCE TESTS COMPLETED

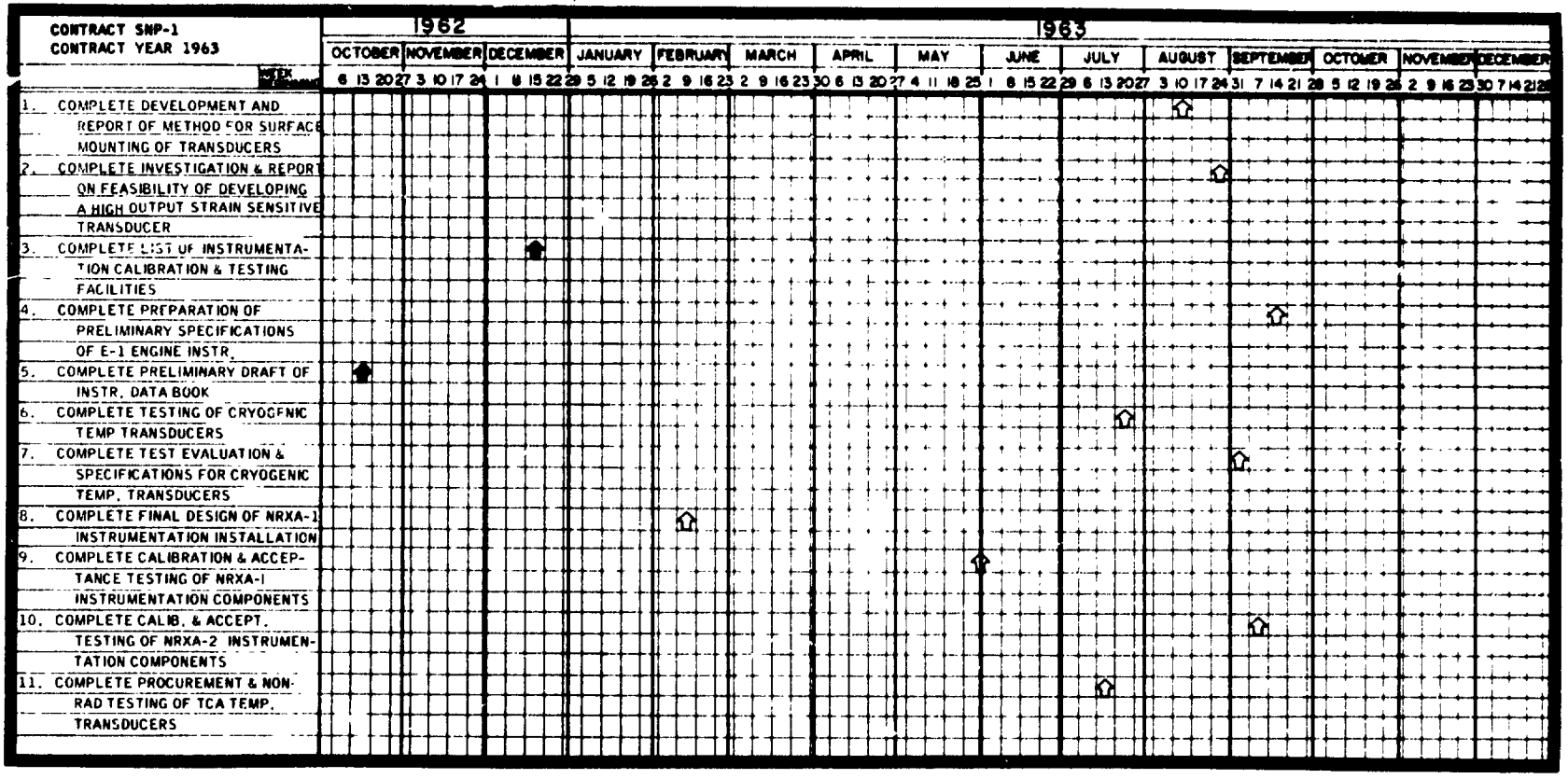
◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 28 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 2.4
INSTRUMENTATION

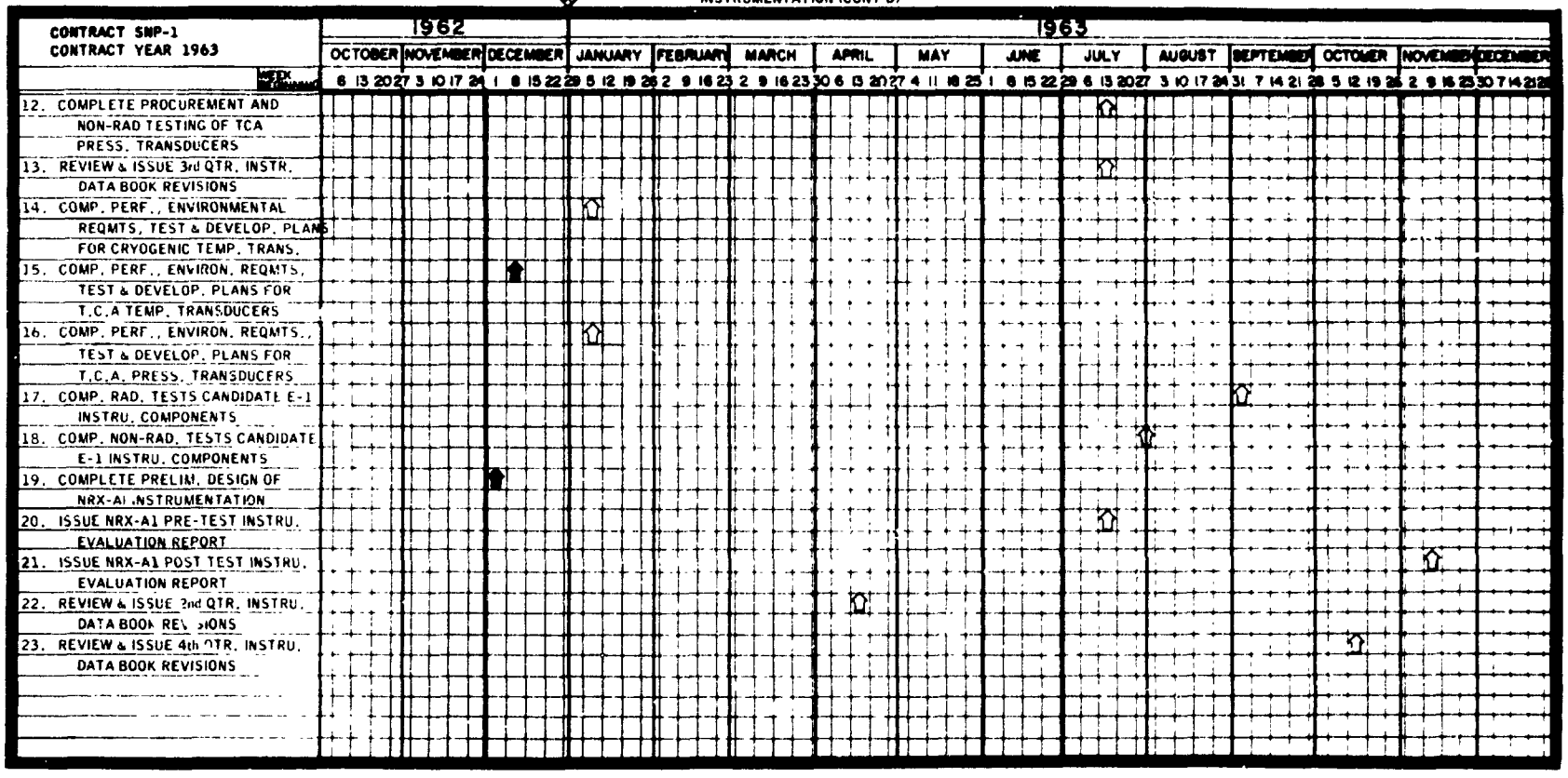

CONTRACT SNP-1
CONTRACT YEAR 1963
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
1. COMPLETE DEVELOPMENT AND REPORT OF METHOD FOR SURFACE MOUNTING OF TRANSDUCERS
2. COMPLETE INVESTIGATION & REPORT ON FEASIBILITY OF DEVELOPING A HIGH OUTPUT STRAIN SENSITIVE TRANSDUCER
3. COMPLETE LIST OF INSTRUMENTATION CALIBRATION & TESTING FACILITIES
4. COMPLETE PREPARATION OF PRELIMINARY SPECIFICATIONS OF E-1 ENGINE INSTR.
5. COMPLETE PRELIMINARY DRAFT OF INSTR. DATA BOOK
6. COMPLETE TESTING OF CRYOGENIC TEMP TRANSDUCERS
7. COMPLETE TEST EVALUATION & SPECIFICATIONS FOR CRYOGENIC TEMP. TRANSDUCERS
8. COMPLETE FINAL DESIGN OF NRXA-1 INSTRUMENTATION INSTALLATION
9. COMPLETE CALIBRATION & ACCEPTANCE TESTING OF NRXA-1 INSTRUMENTATION COMPONENTS
10. COMPLETE CALIB. & ACCEPT. TESTING OF NRXA-2 INSTRUMENTATION COMPONENTS
11. COMPLETE PROCUREMENT & NON-RAD TESTING OF TCA TEMP. TRANSDUCERS
SCHEDULED MILESTONE
RESCHEDULED MILESTONE
MILESTONE ACHIEVEMENT
RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 29 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 2.4
INSTRUMENTATION (CONT'D)


CONTRACT SNP-1
CONTRACT YEAR 1963
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
12. COMPLETE PROCUREMENT AND
NON-RAD TESTING OF TCA
PRESS. TRANSDUCERS
13. REVIEW & ISSUE 3rd QTR. INSTR.
DATA BOOK REVISIONS
14. COMP. PERF., ENVIRONMENTAL
REQMTS, TEST & DEVELOP. PLANS
FOR CRYOGENIC TEMP. TRANS.
15. COMP. PERF., ENVIRON. REQMTS,
TEST & DEVELOP. PLANS FOR
T.C.A TEMP. TRANSDUCERS
16. COMP. PERF., ENVIRON. REQMTS.,
TEST & DEVELOP. PLANS FOR
T.C.A. PRESS. TRANSDUCERS
17. COMP. RAD. TESTS CANDIDATE E-1
INSTRU. COMPONENTS
18. COMP. NON-RAD. TESTS CANDIDATE
E-1 INSTRU. COMPONENTS
19. COMPLETE PRELIM. DESIGN OF
NRX-A1 INSTRUMENTATION
20. ISSUE NRX-A1 PRE-TEST INSTRU.
EVALUATION REPORT
21. ISSUE NRX-A1 POST TEST INSTRU.
EVALUATION REPORT
22. REVIEW & ISSUE 2nd QTR. INSTRU.
DATA BOOK REVISIONS
23. REVIEW & ISSUE 4th QTR. INSTRU.
DATA BOOK REVISIONS

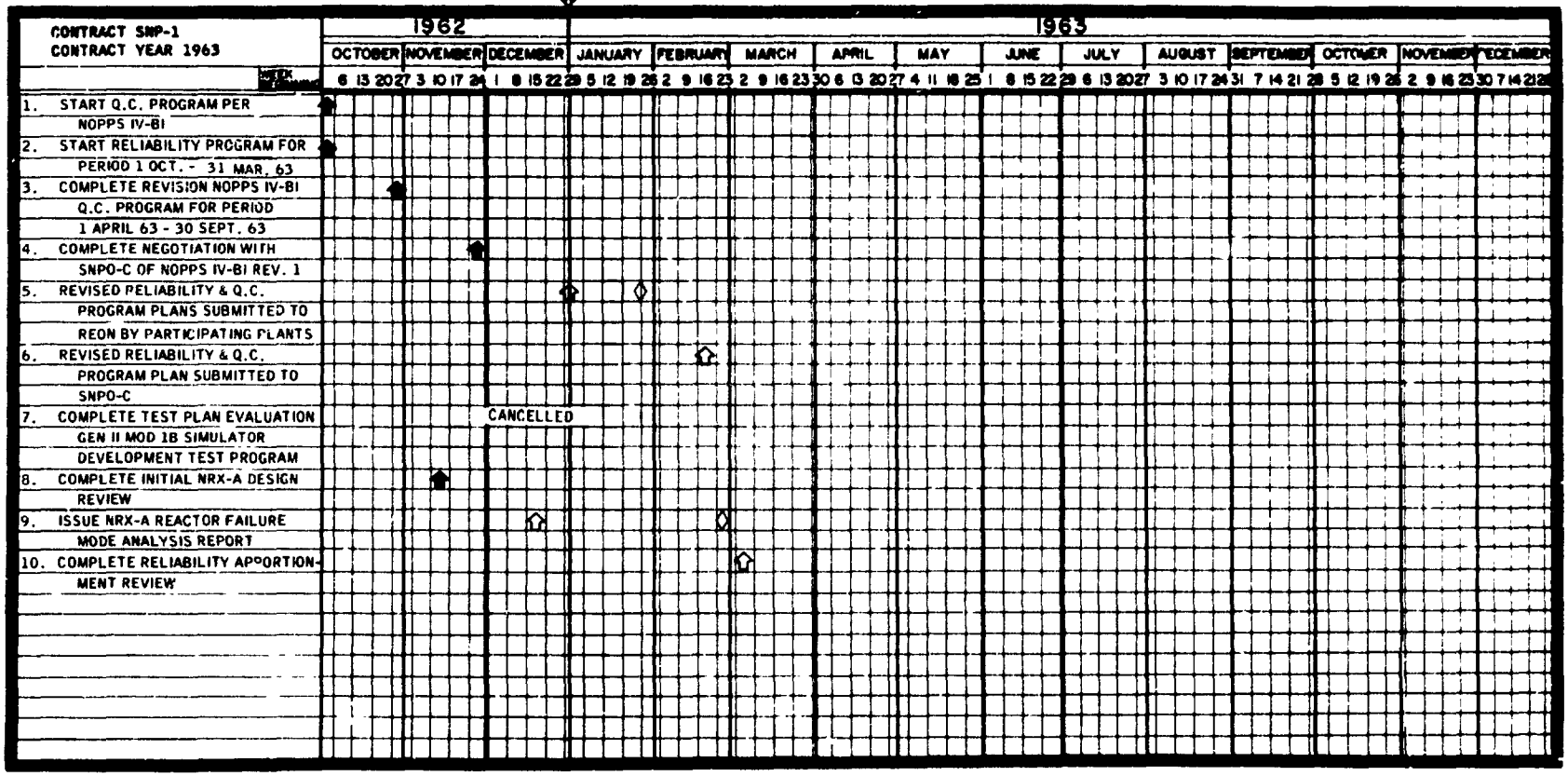
◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 30 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 2.6
RELIABILITY AND QUALITY ASSURANCE


CONTRACT SNP-1
CONTRACT YEAR 1963
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
1. START Q.C. PROGRAM PER NOPPS IV-BI
2. START RELIABILITY PROGRAM FOR PERIOD 1 OCT. - 31 MAR. 63
3. COMPLETE REVISION NOPPS IV-BI Q.C. PROGRAM FOR PERIOD 1 APRIL 63 - 30 SEPT. 63
4. COMPLETE NEGOTIATION WITH SNPO-C OF NOPPS IV-BI REV. 1
5. REVISED RELIABILITY & Q.C. PROGRAM PLANS SUBMITTED TO REON BY PARTICIPATING PLANTS
6. REVISED RELIABILITY & Q.C. PROGRAM PLAN SUBMITTED TO SNPO-C
7. COMPLETE TEST PLAN EVALUATION GEN II MOD 1B SIMULATOR DEVELOPMENT TEST PROGRAM
CANCELLED
8. COMPLETE INITIAL NRX-A DESIGN REVIEW
9. ISSUE NRX-A REACTOR FAILURE MODE ANALYSIS REPORT
10. COMPLETE RELIABILITY APPORTIONMENT REVIEW

◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

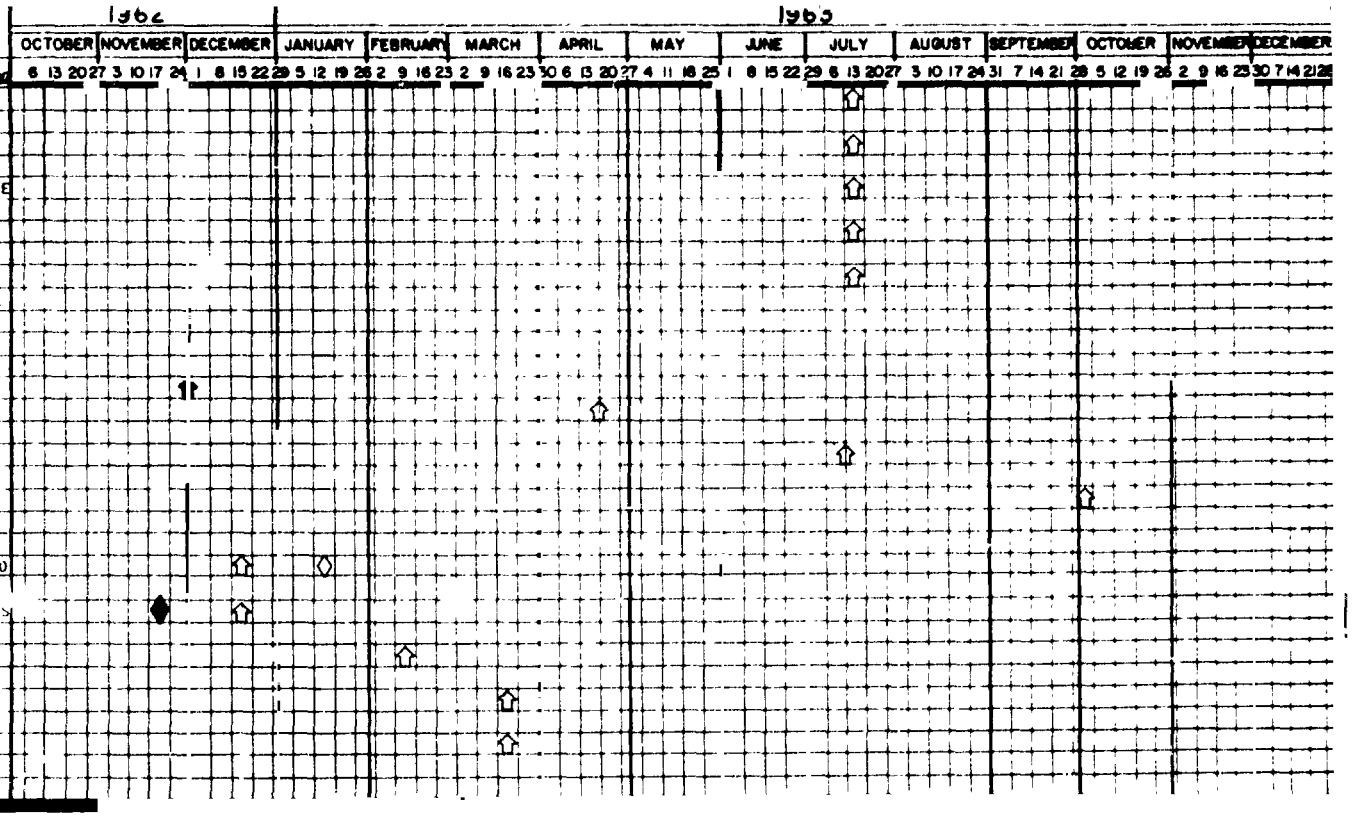
Figure 1
Sheet 31 of 54

CONFIDENTIAL

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 2.7
SAFETY

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
1 ESTABLISH INITIAL SAFETY OPERATION & TRAINING
2. ESTABLISH PERSONNEL MONITORING PROCEDURE
3. ESTABLISH PERSONAL PROTECTIVE EQUIPMENT PROGRAM
4. PREPARE AND ISSUE HEALTH AND SAFETY PROCEDURES
5. ESTABLISH PRELIMINARY RADIATION ENVIRONMENTAL CONTROL PROGRAM
6. INITIAL SAFETY PRESENTATION FOR RIFT SAFETY REVIEW PROGRAM
7. ISSUE PRELIMINARY NRX-A SAFEGUARDS REPORT, 20 APRIL '63
8. ISSUE FINAL NRX-A SAFEGUARDS REPORT, 13 JULY 1963
9. ISSUE PRELIMINARY E-MAD RADIATION HAZARDS & SAFETY REPORT, 30 SEPT 1963
10. PROOF TEST SAFEGUARDS *27,0 REPORT ISSUED
11. ISSUE INITIAL REPORT OF HAZARDS EVALUATION
12. ASSEMBLY AND SHIPPING SAFEGUARDS REPORT ISSUED
13. NRX-A ACCIDENT ANALYSIS AND SAFEGUARDS REPORT ISSUED
14. ISSUE HAZARDS CONSIDERATION REPORT FOR REACTOR TEST

⇧ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
⬆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

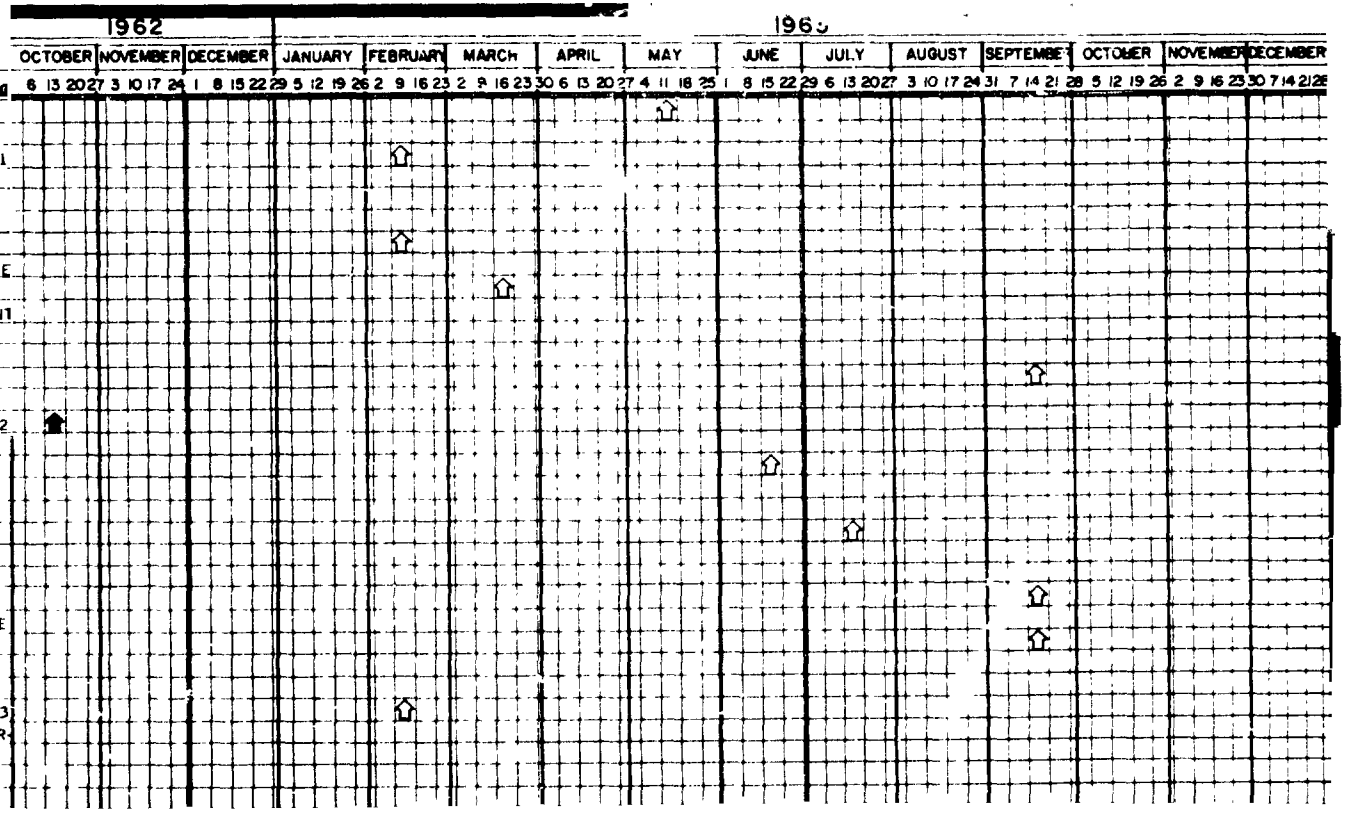
REON

Figure 1
Sheet 32 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 2 7
SAFETY

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
15. NRX-A DISASSEMBLY OPERATION SAFEGUARDS REPORT ISSUED
16. INITIAL FISSION PRODUCT #2731 RELEASE EXPERIMENTAL AND RADIO CHEMICAL ANALYSIS COMPLETE
17. ANALYSIS OF INITIAL DIFFUSION EXPERIMENTAL DATA COMPLETE
18. SPECIFY DOWN-WIND EFFLUENT COLLECTION AND FUEL ELEMENT RADIOACTIVITY ANALYSIS FOR NRX-A TESTS
19. DIFFUSION COMPUTER CODE CHECKOUT COMPLETE
20. START TREAT EXCURSION #2732 EXPERIMENTS USING NEW FUEL
21. PRELIMINARY EVALUATION OF REACTOR EXCURSION MODEL COMPLETE
22. ANALYSIS OF ENERGY TRANSFER MECHANISMS DURING EXCURSION COMPLETE
23. EXPERIMENTS ON CORE COMPACTION DUE TO IMPACT COMPLETE
24. COMPLETE SERIES OF TREAT EXCURSION EXPERIMENTS USING NEW FUEL
25. SURVEY OF NON-FUEL #2733 MATERIAL BURN-UP CHARACTERISTICS COMPLETE

⌂ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
⌂ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

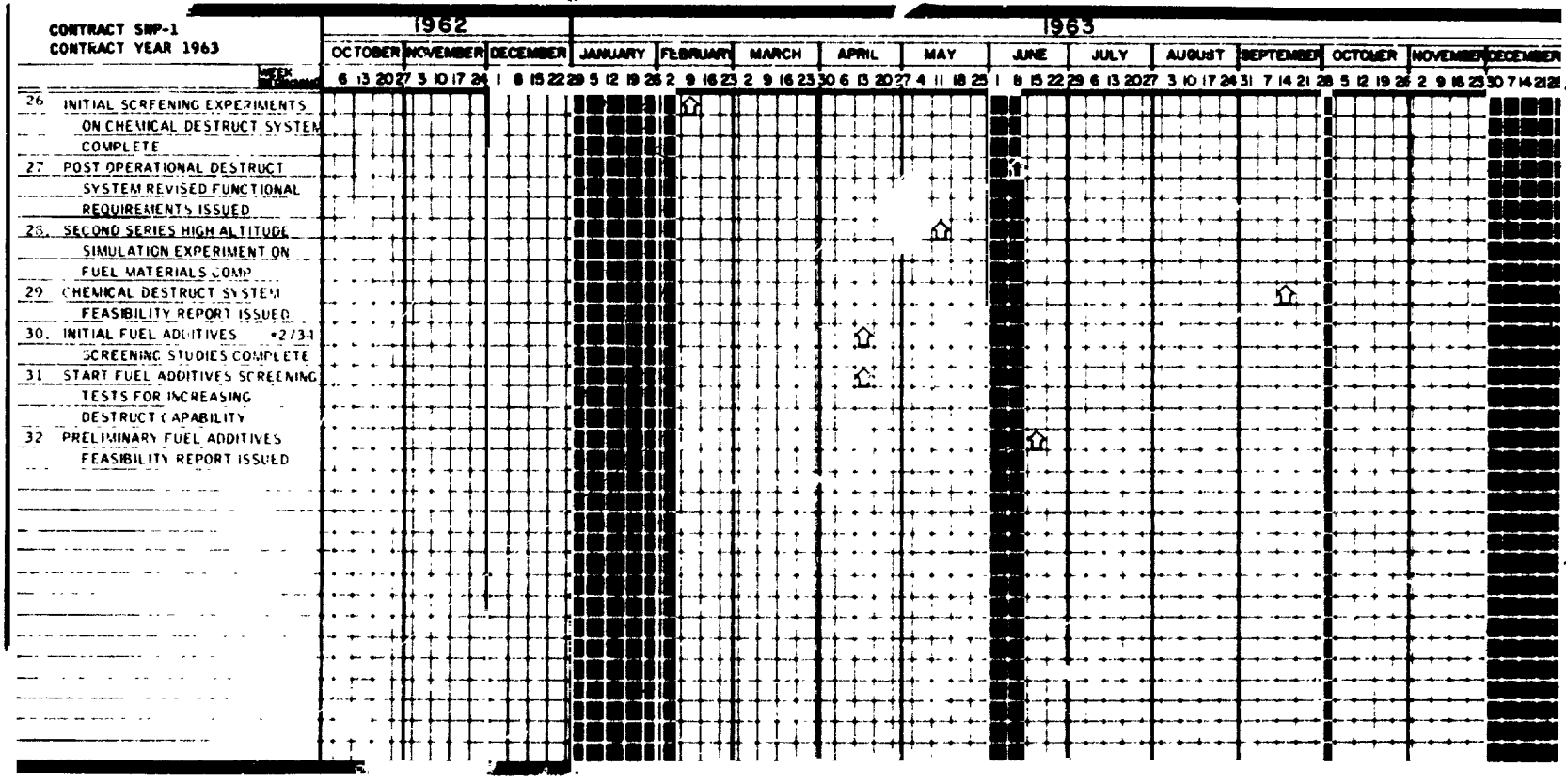
REON

Figure 1
Sheet 33 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 2.7
SAFETY

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
26 INITIAL SCREENING EXPERIMENTS ON CHEMICAL DESTRUCT SYSTEM COMPLETE
27 POST OPERATIONAL DESTRUCT SYSTEM REVISED FUNCTIONAL REQUIREMENTS ISSUED
28 SECOND SERIES HIGH ALTITUDE SIMULATION EXPERIMENT ON FUEL MATERIALS COMP
29 CHEMICAL DESTRUCT SYSTEM FEASIBILITY REPORT ISSUED
30 INITIAL FUEL ADDITIVES SCREENING STUDIES COMPLETE *2734
31 START FUEL ADDITIVES SCREENING TESTS FOR INCREASING DESTRUCT CAPABILITY
32 PRELIMINARY FUEL ADDITIVES FEASIBILITY REPORT ISSUED

⇧ SCHEDULED MILESTONE
⇧ RESCHEDULED MILESTONE
⬆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

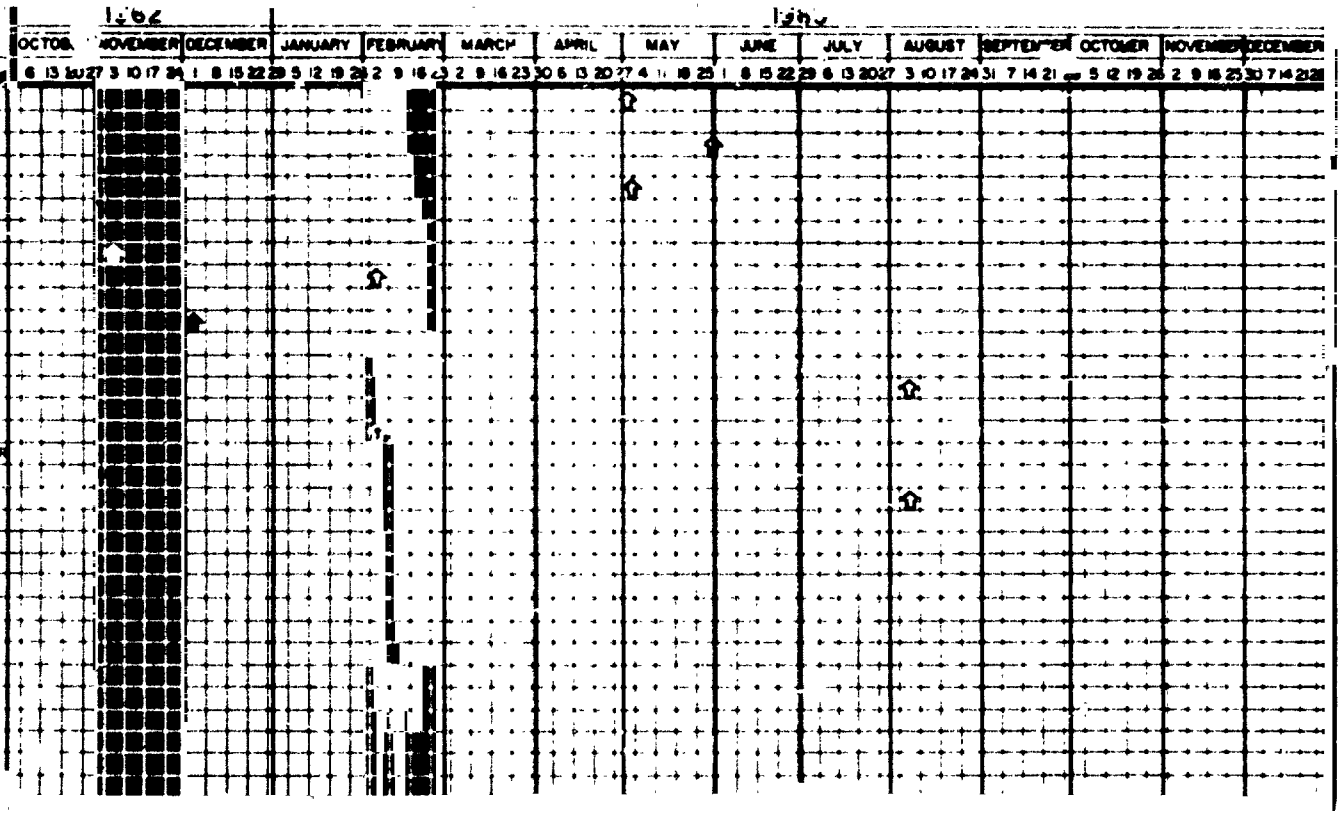
REON

Figure 1
Sheet 34 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 2.
TRAINING

CONTRACT SNP-1
CONTRACT YEAR 1963



⇧ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
⬟ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

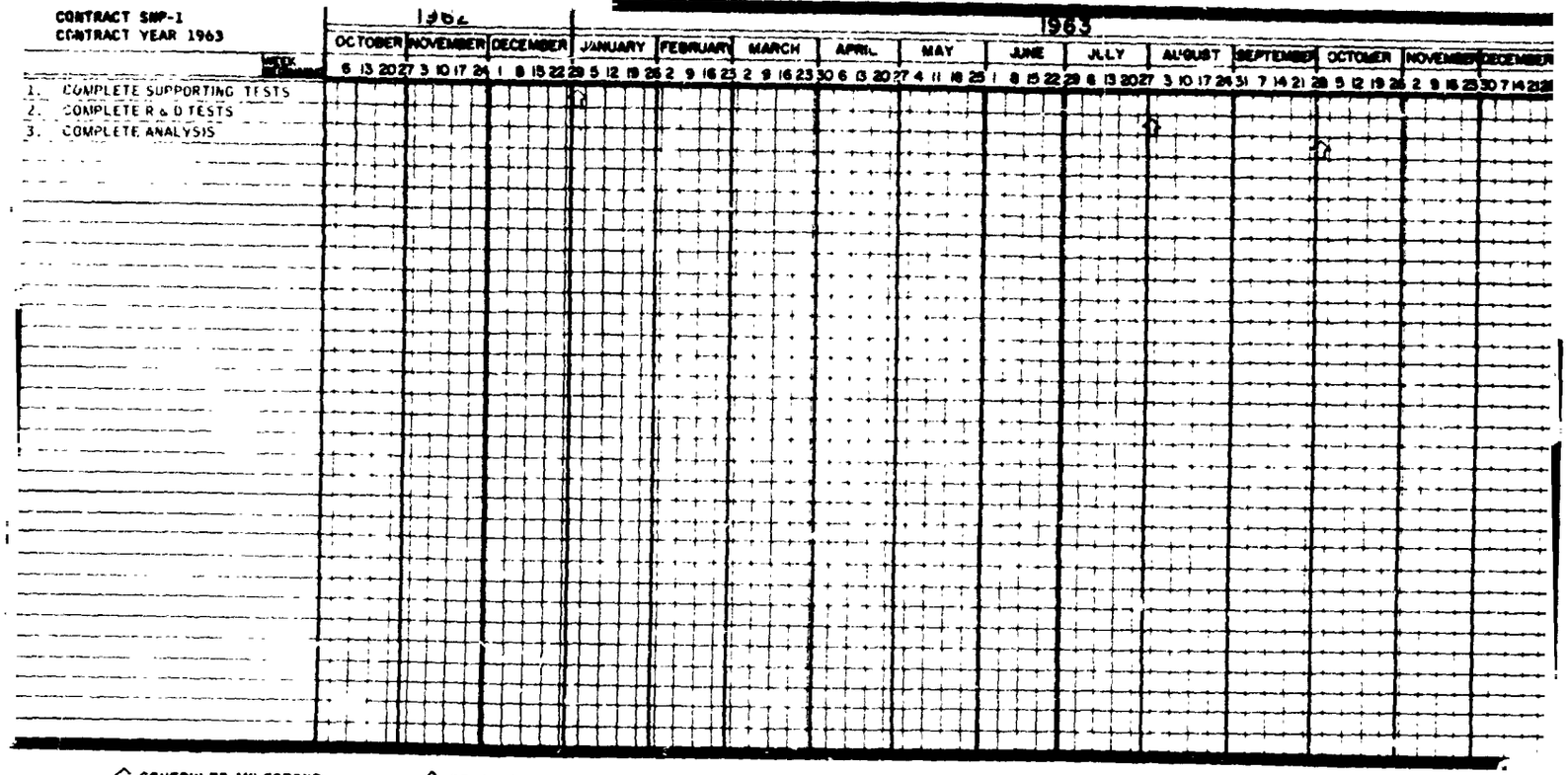
REON

Figure 1
Sheet 35 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 3.1
EXHAUST SYSTEM DEVELOPMENT PROGRAM

CONTRACT SNP-1
CONTRACT YEAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
1. COMPLETE SUPPORTING TESTS
2. COMPLETE R & D TESTS
3. COMPLETE ANALYSIS

SCHEDULED MILESTONE
MILESTONE ACHIEVEMENT
RESCHEDULED MILESTONE
RESCHEDULED MILESTONE ACHIEVEMENT

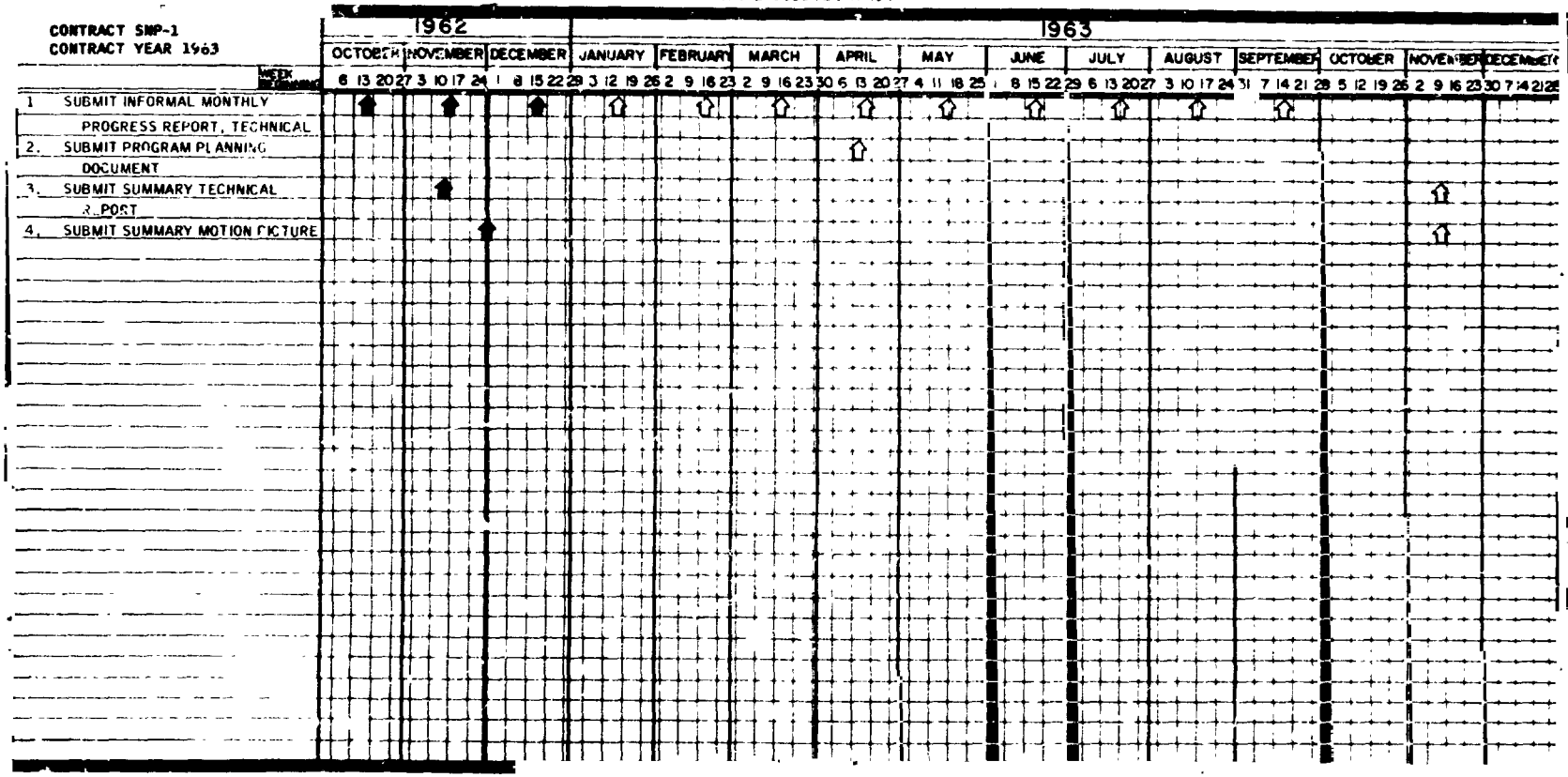
REON

Figure 1
Sheet 36 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 4.5
ADDITIONAL DOCUMENTATION

CONTRACT SNP-1
CONTRACT YEAR 1963



◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

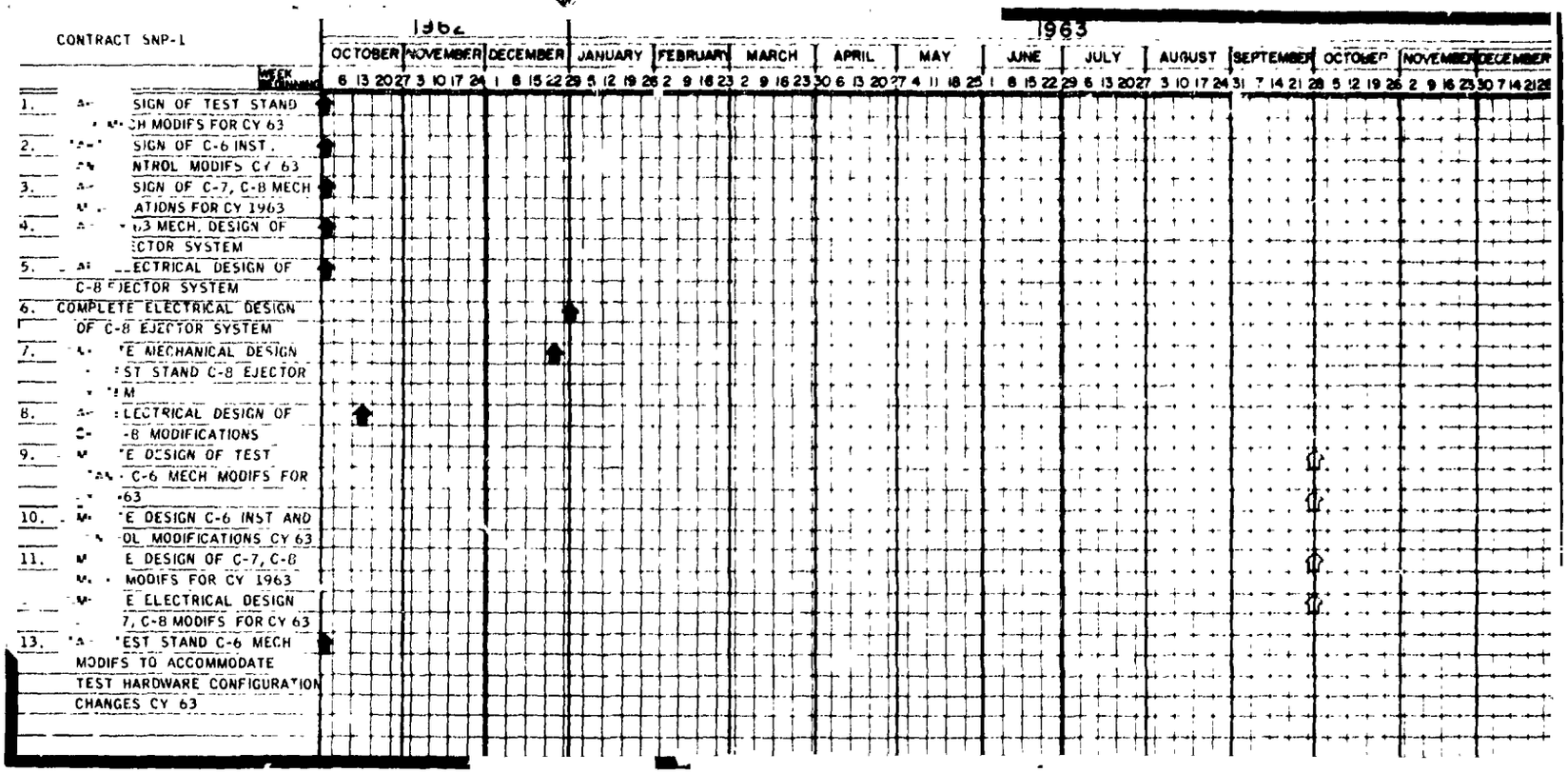
REON

Figure 1
Sheet 37 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 5.1
DESIGN AND CONSTRUCTION MANAGEMENT

CONTRACT SNP-1


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
1. SIGN OF TEST STAND
CH MODIFS FOR CY 63
2. SIGN OF C-6 INST.
NTROL MODIFS CY 63
3. SIGN OF C-7, C-8 MECH
ATIONS FOR CY 1963
4. 63 MECH. DESIGN OF
ECTOR SYSTEM
5. ECTRICAL DESIGN OF
C-8 EJECTOR SYSTEM
6. COMPLETE ELECTRICAL DESIGN
OF C-8 EJECTOR SYSTEM
7. E MECHANICAL DESIGN
ST STAND C-8 EJECTOR
M
8. ELECTRICAL DESIGN OF
-8 MODIFICATIONS
9. E DESIGN OF TEST
C-6 MECH MODIFS FOR
63
10. E DESIGN C-6 INST AND
OL MODIFICATIONS CY 63
11. E DESIGN OF C-7, C-8
MODIFS FOR CY 1963
E ELECTRICAL DESIGN
7, C-8 MODIFS FOR CY 63
13. EST STAND C-6 MECH
MODIFS TO ACCOMMODATE
TEST HARDWARE CONFIGURATION
CHANGES CY 63

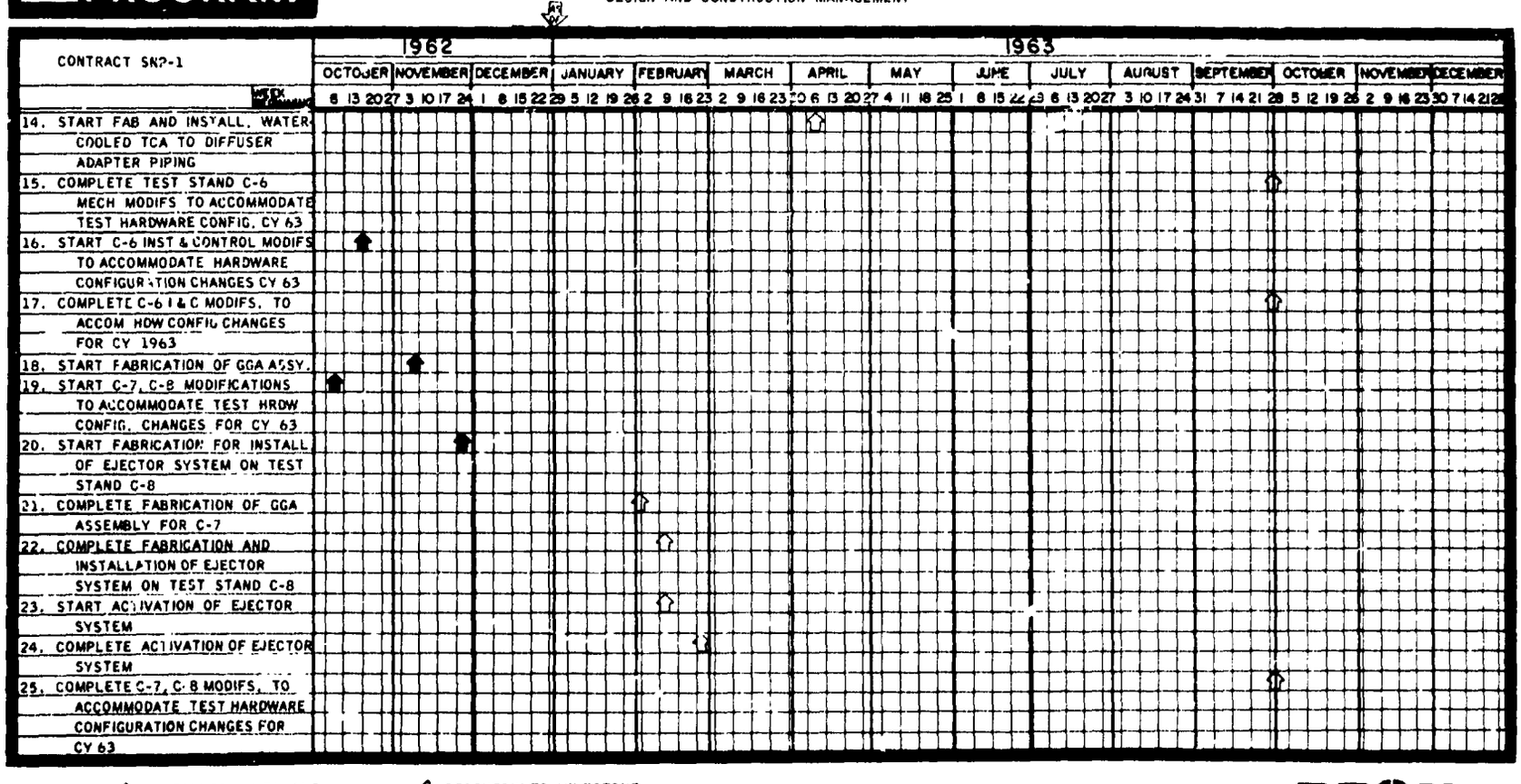
◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 38 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 5.1
DESIGN AND CONSTRUCTION MANAGEMENT

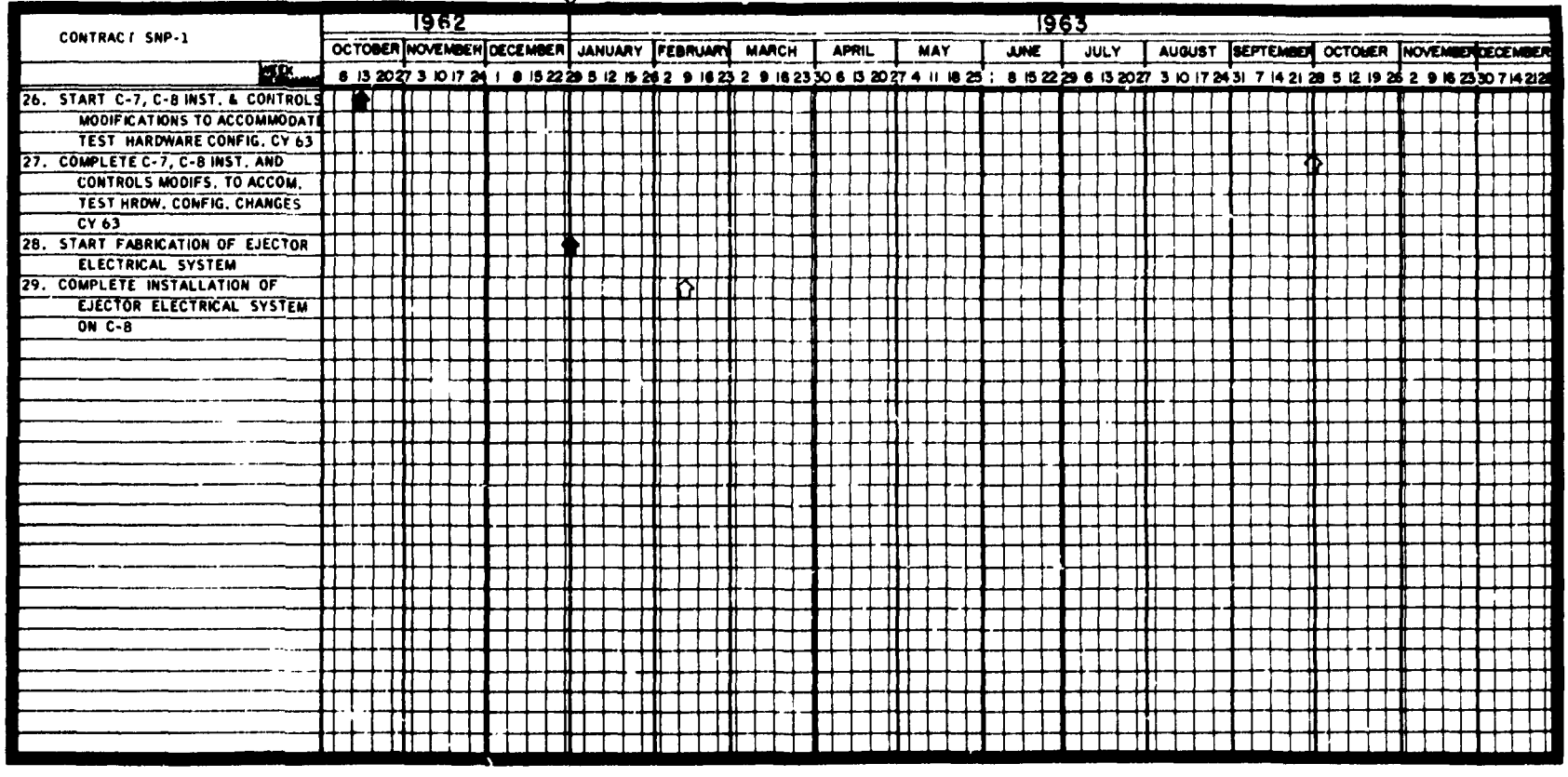

CONTRACT SNP-1
1962
1963
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
WEEK ENDING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
14. START FAB AND INSTALL. WATER-COOLED TCA TO DIFFUSER ADAPTER PIPING
15. COMPLETE TEST STAND C-6 MECH MODIFS TO ACCOMMODATE TEST HARDWARE CONFIG. CY 63
16. START C-6 INST & CONTROL MODIFS TO ACCOMMODATE HARDWARE CONFIGURATION CHANGES CY 63
17. COMPLETE C-6 I & C MODIFS. TO ACCOM HDW CONFIG CHANGES FOR CY 1963
18. START FABRICATION OF GGA ASSY.
19. START C-7, C-8 MODIFICATIONS TO ACCOMMODATE TEST HDW CONFIG. CHANGES FOR CY 63
20. START FABRICATION FOR INSTALL OF EJECTOR SYSTEM ON TEST STAND C-8
21. COMPLETE FABRICATION OF GGA ASSEMBLY FOR C-7
22. COMPLETE FABRICATION AND INSTALLATION OF EJECTOR SYSTEM ON TEST STAND C-8
23. START ACTIVATION OF EJECTOR SYSTEM
24. COMPLETE ACTIVATION OF EJECTOR SYSTEM
25. COMPLETE C-7, C-8 MODIFS. TO ACCOMMODATE TEST HARDWARE CONFIGURATION CHANGES FOR CY 63

⇧ SCHEDULED MILESTONE
⇩ RESCHEDULED MILESTONE
⬆ MILESTONE ACHIEVEMENT
⬇ RESCHEDULED MILESTONE ACHIEVEMENT

REON

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 5.1
DESIGN AND CONSTRUCTION MANAGEMENT


CONTRACT SNP-1
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK
8 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
26. START C-7, C-8 INST. & CONTROLS MODIFICATIONS TO ACCOMMODATE TEST HARDWARE CONFIG. CY 63
27. COMPLETE C-7, C-8 INST. AND CONTROLS MODIFS. TO ACCOM. TEST HRDW. CONFIG. CHANGES CY 63
28. START FABRICATION OF EJECTOR ELECTRICAL SYSTEM
29. COMPLETE INSTALLATION OF EJECTOR ELECTRICAL SYSTEM ON C-8

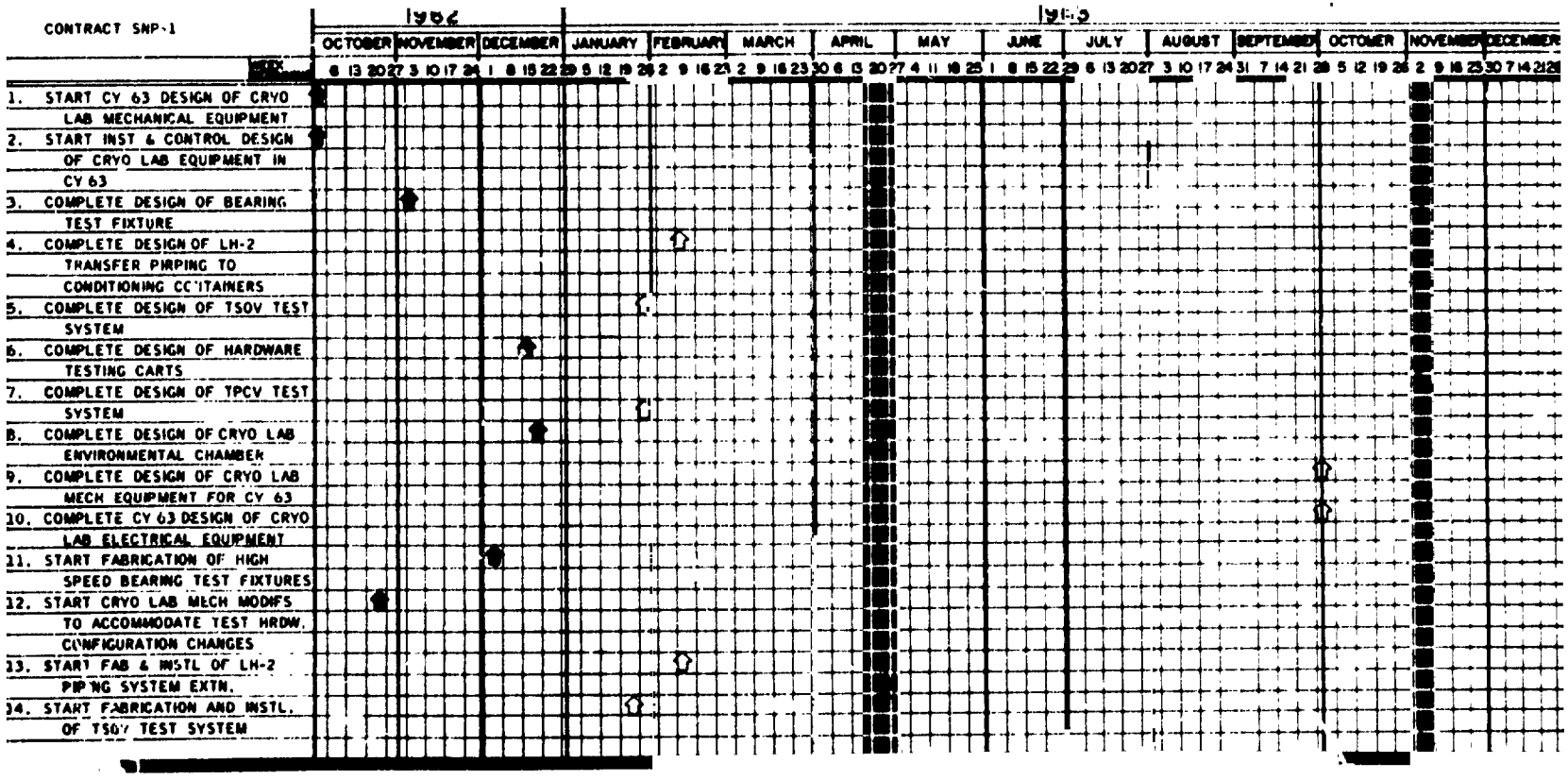
◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

Figure 1
Sheet 40 of 54

REON

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 5.2
DESIGN AND CONSTRUCTION MANAGEMENT


CONTRACT SNP-1
1962
1963
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
WEEK
1. START CY 63 DESIGN OF CRYO LAB MECHANICAL EQUIPMENT
2. START INST & CONTROL DESIGN OF CRYO LAB EQUIPMENT IN CY 63
3. COMPLETE DESIGN OF BEARING TEST FIXTURE
4. COMPLETE DESIGN OF LH-2 TRANSFER PIPING TO CONDITIONING CONTAINERS
5. COMPLETE DESIGN OF TSOV TEST SYSTEM
6. COMPLETE DESIGN OF HARDWARE TESTING CARTS
7. COMPLETE DESIGN OF TPCV TEST SYSTEM
8. COMPLETE DESIGN OF CRYO LAB ENVIRONMENTAL CHAMBER
9. COMPLETE DESIGN OF CRYO LAB MECH EQUIPMENT FOR CY 63
10. COMPLETE CY 63 DESIGN OF CRYO LAB ELECTRICAL EQUIPMENT
11. START FABRICATION OF HIGH SPEED BEARING TEST FIXTURES
12. START CRYO LAB MECH MODIFS TO ACCOMMODATE TEST HRDW. CONFIGURATION CHANGES
13. START FAB & INSTL OF LH-2 PIPING SYSTEM EXTN.
14. START FABRICATION AND INSTL. OF TSOV TEST SYSTEM

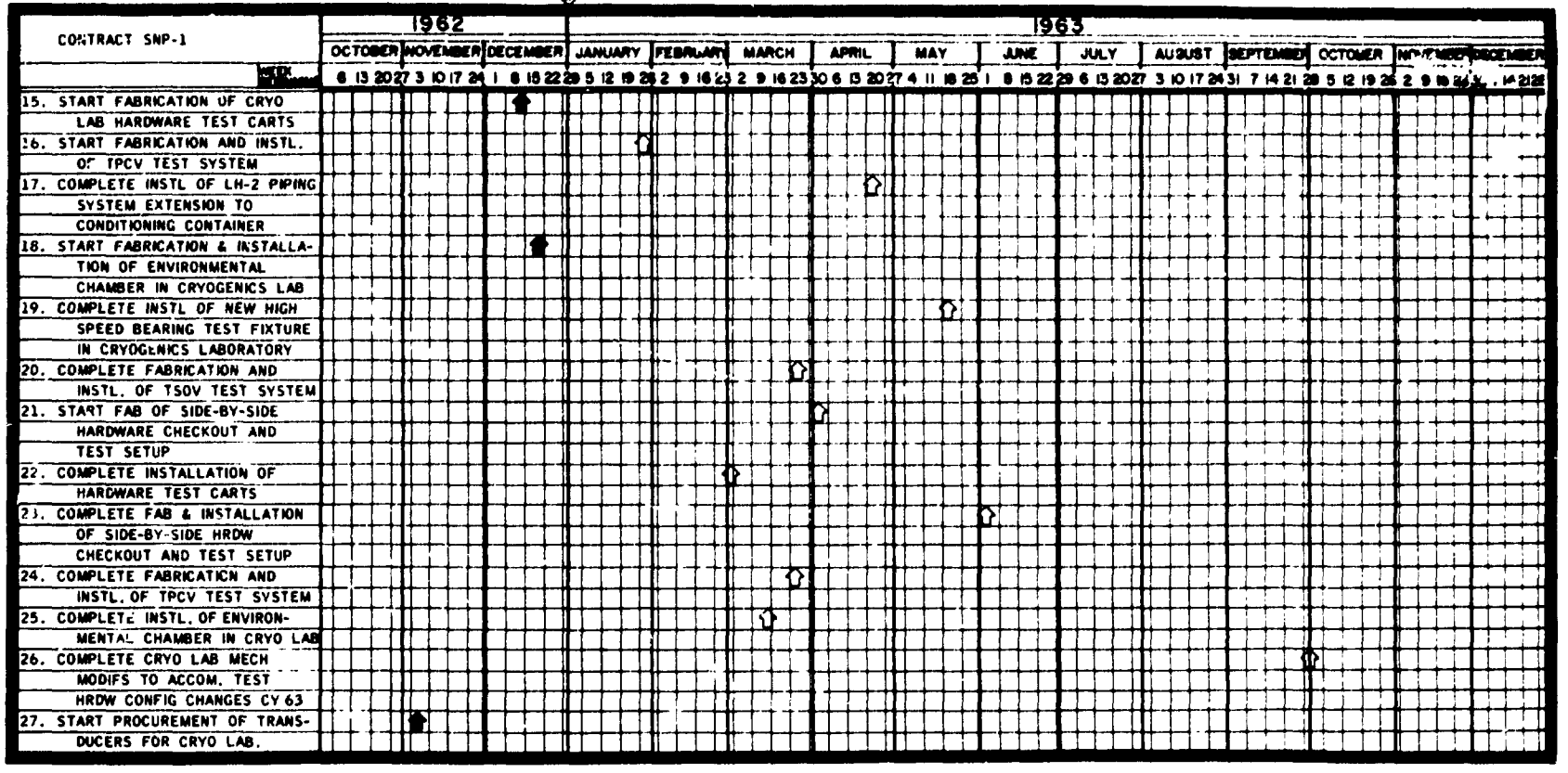
IEDULED MILESTONE
ILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEME

REON

Figure 1
Sheet 41 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 5.2
DESIGN AND CONSTRUCTION MANAGEMENT

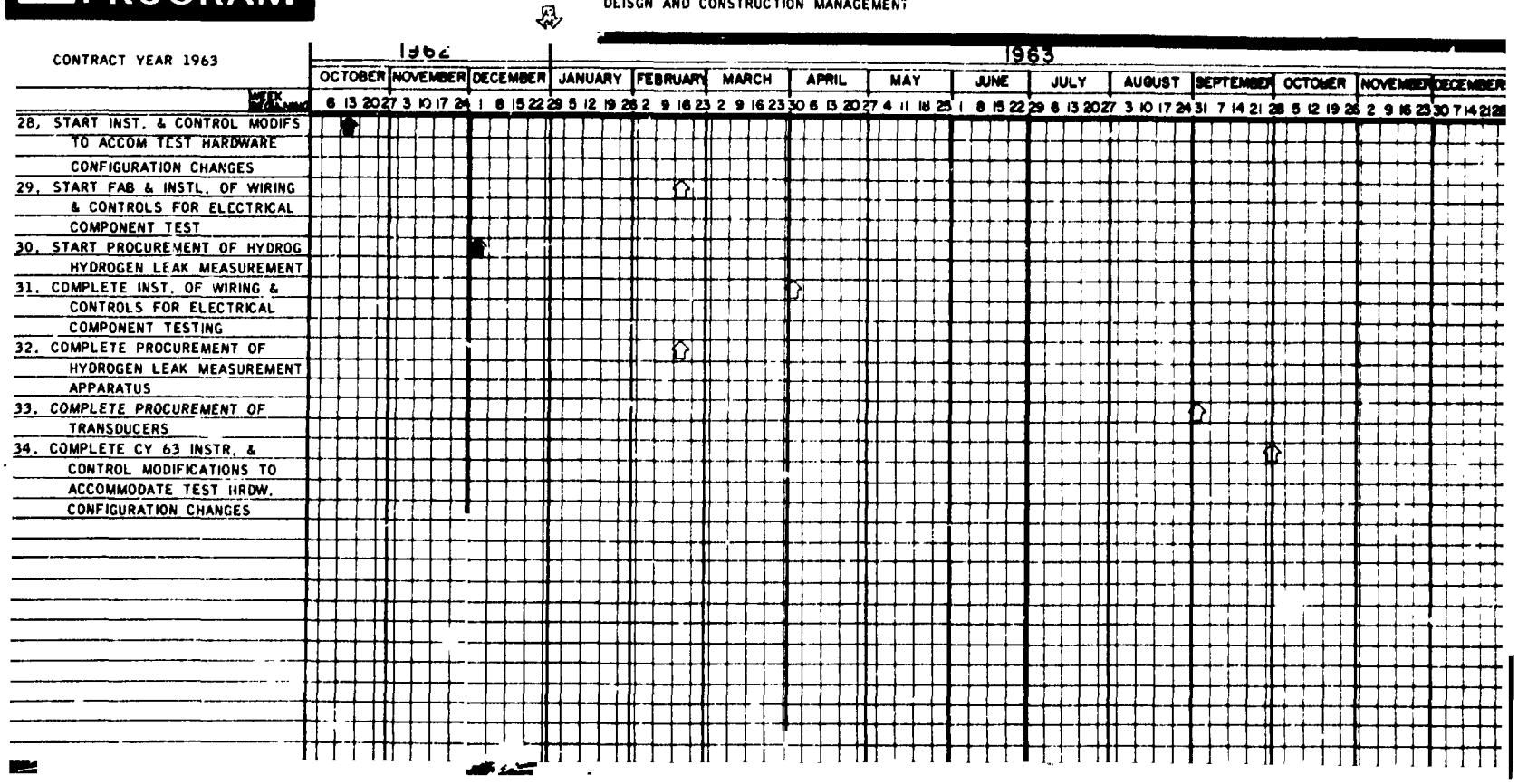

CONTRACT SNP-1
1962
1963
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
DECEMBER
15. START FABRICATION OF CRYO LAB HARDWARE TEST CARTS
16. START FABRICATION AND INSTL. OF TPCV TEST SYSTEM
17. COMPLETE INSTL OF LH-2 PIPING SYSTEM EXTENSION TO CONDITIONING CONTAINER
18. START FABRICATION & INSTALLATION OF ENVIRONMENTAL CHAMBER IN CRYOGENICS LAB
19. COMPLETE INSTL OF NEW HIGH SPEED BEARING TEST FIXTURE IN CRYOGENICS LABORATORY
20. COMPLETE FABRICATION AND INSTL. OF TSOV TEST SYSTEM
21. START FAB OF SIDE-BY-SIDE HARDWARE CHECKOUT AND TEST SETUP
22. COMPLETE INSTALLATION OF HARDWARE TEST CARTS
23. COMPLETE FAB & INSTALLATION OF SIDE-BY-SIDE HRDW CHECKOUT AND TEST SETUP
24. COMPLETE FABRICATION AND INSTL. OF TPCV TEST SYSTEM
25. COMPLETE INSTL. OF ENVIRONMENTAL CHAMBER IN CRYO LAB
26. COMPLETE CRYO LAB MECH MODIFS TO ACCOM. TEST HRDW CONFIG CHANGES CY 63
27. START PROCUREMENT OF TRANSDUCERS FOR CRYO LAB.

◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 5.2
DEISGN AND CONSTRUCTION MANAGEMENT


CONTRACT YEAR 1963
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK ENDING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
28, START INST. & CONTROL MODIFS TO ACCOM TEST HARDWARE CONFIGURATION CHANGES
29, START FAB & INSTL. OF WIRING & CONTROLS FOR ELECTRICAL COMPONENT TEST
30, START PROCUREMENT OF HYDROG HYDROGEN LEAK MEASUREMENT
31, COMPLETE INST. OF WIRING & CONTROLS FOR ELECTRICAL COMPONENT TESTING
32, COMPLETE PROCUREMENT OF HYDROGEN LEAK MEASUREMENT APPARATUS
33, COMPLETE PROCUREMENT OF TRANSDUCERS
34, COMPLETE CY 63 INSTR. & CONTROL MODIFICATIONS TO ACCOMMODATE TEST HRDW. CONFIGURATION CHANGES

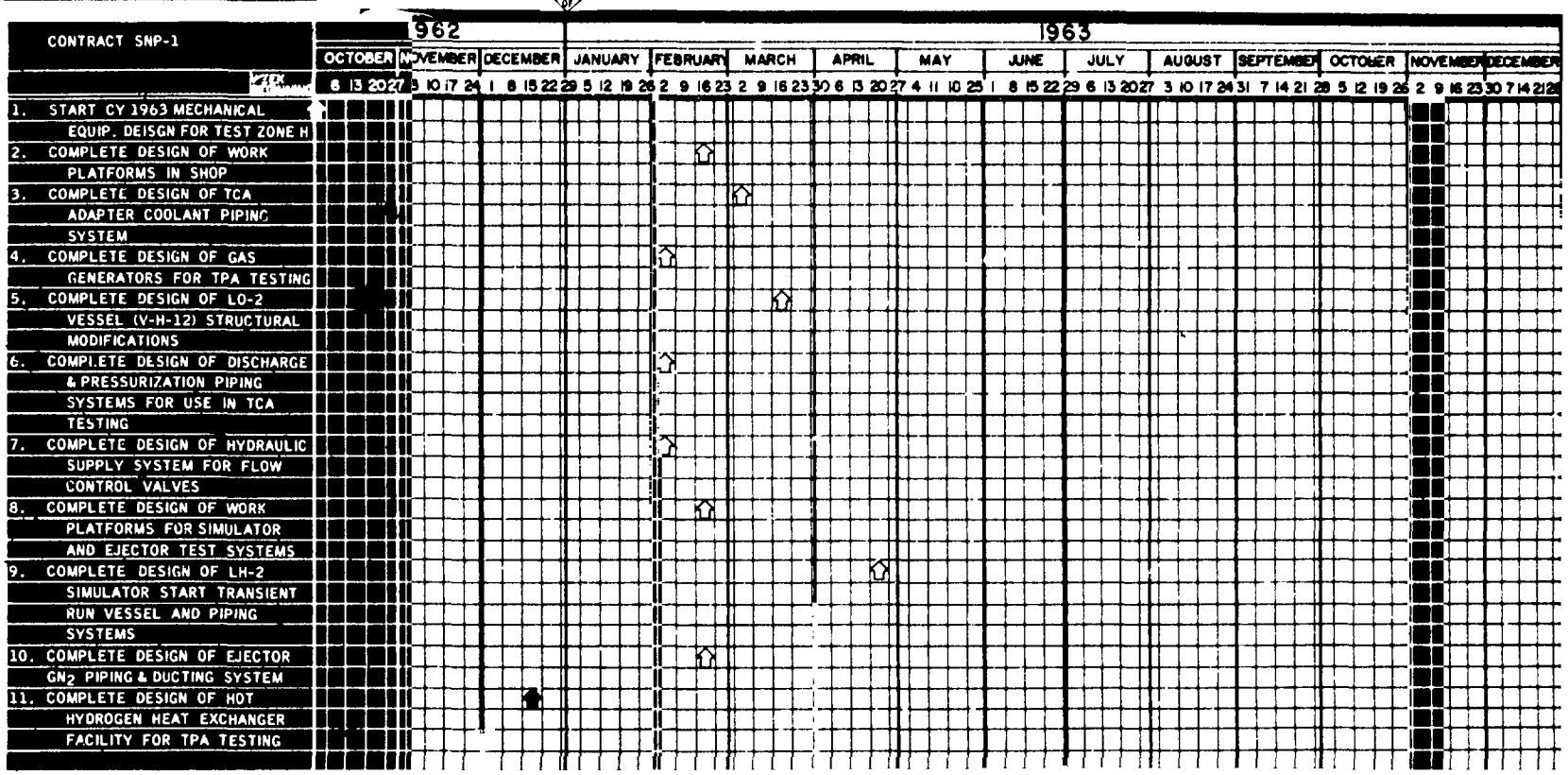
◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

Figure 1
Sheet 43 of 54

REON

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEm 5.3
DESIGN AND CONSTRUCTION MANAGEMENT

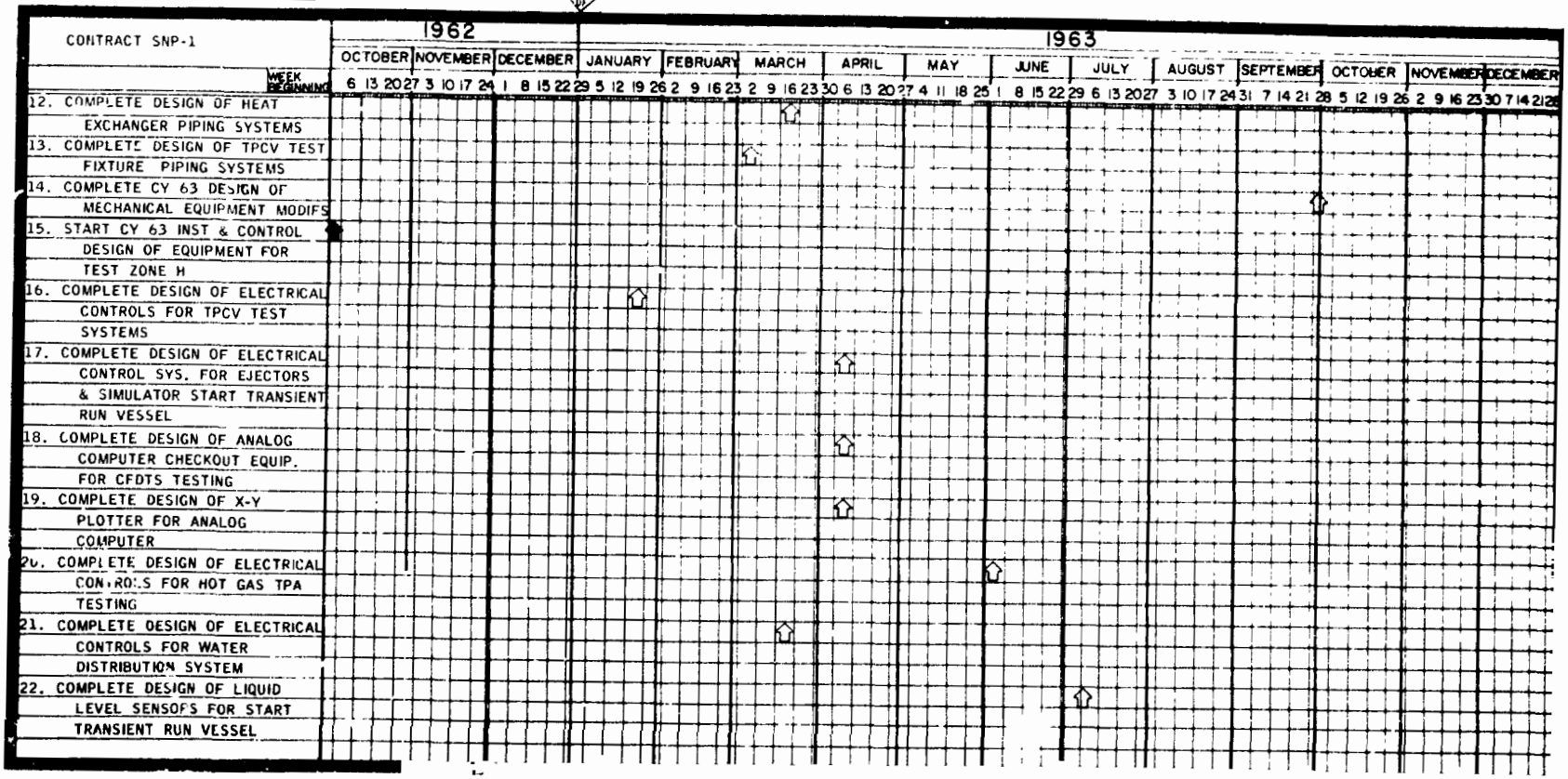

CONTRACT SNP-1
1962
1963
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
1. START CY 1963 MECHANICAL EQUIP. DEISGN FOR TEST ZONE H
2. COMPLETE DESIGN OF WORK PLATFORMS IN SHOP
3. COMPLETE DESIGN OF TCA ADAPTER COOLANT PIPING SYSTEM
4. COMPLETE DESIGN OF GAS GENERATORS FOR TPA TESTING
5. COMPLETE DESIGN OF LO-2 VESSEL (V-H-12) STRUCTURAL MODIFICATIONS
6. COMPLETE DESIGN OF DISCHARGE & PRESSURIZATION PIPING SYSTEMS FOR USE IN TCA TESTING
7. COMPLETE DESIGN OF HYDRAULIC SUPPLY SYSTEM FOR FLOW CONTROL VALVES
8. COMPLETE DESIGN OF WORK PLATFORMS FOR SIMULATOR AND EJECTOR TEST SYSTEMS
9. COMPLETE DESIGN OF LH-2 SIMULATOR START TRANSIENT RUN VESSEL AND PIPING SYSTEMS
10. COMPLETE DESIGN OF EJECTOR GN_2 PIPING & DUCTING SYSTEM
11. COMPLETE DESIGN OF HOT HYDROGEN HEAT EXCHANGER FACILITY FOR TPA TESTING

◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 5.3
DESIGN AND CONSTRUCTION MANAGEMENT


CONTRACT SNP-1
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
12. COMPLETE DESIGN OF HEAT EXCHANGER PIPING SYSTEMS
13. COMPLETE DESIGN OF TPCV TEST FIXTURE PIPING SYSTEMS
14. COMPLETE CY 63 DESIGN OF MECHANICAL EQUIPMENT MODIFS
15. START CY 63 INST & CONTROL DESIGN OF EQUIPMENT FOR TEST ZONE H
16. COMPLETE DESIGN OF ELECTRICAL CONTROLS FOR TPCV TEST SYSTEMS
17. COMPLETE DESIGN OF ELECTRICAL CONTROL SYS. FOR EJECTORS & SIMULATOR START TRANSIENT RUN VESSEL
18. COMPLETE DESIGN OF ANALOG COMPUTER CHECKOUT EQUIP. FOR CFDTS TESTING
19. COMPLETE DESIGN OF X-Y PLOTTER FOR ANALOG COMPUTER
20. COMPLETE DESIGN OF ELECTRICAL CONTROLS FOR HOT GAS TPA TESTING
21. COMPLETE DESIGN OF ELECTRICAL CONTROLS FOR WATER DISTRIBUTION SYSTEM
22. COMPLETE DESIGN OF LIQUID LEVEL SENSORS FOR START TRANSIENT RUN VESSEL

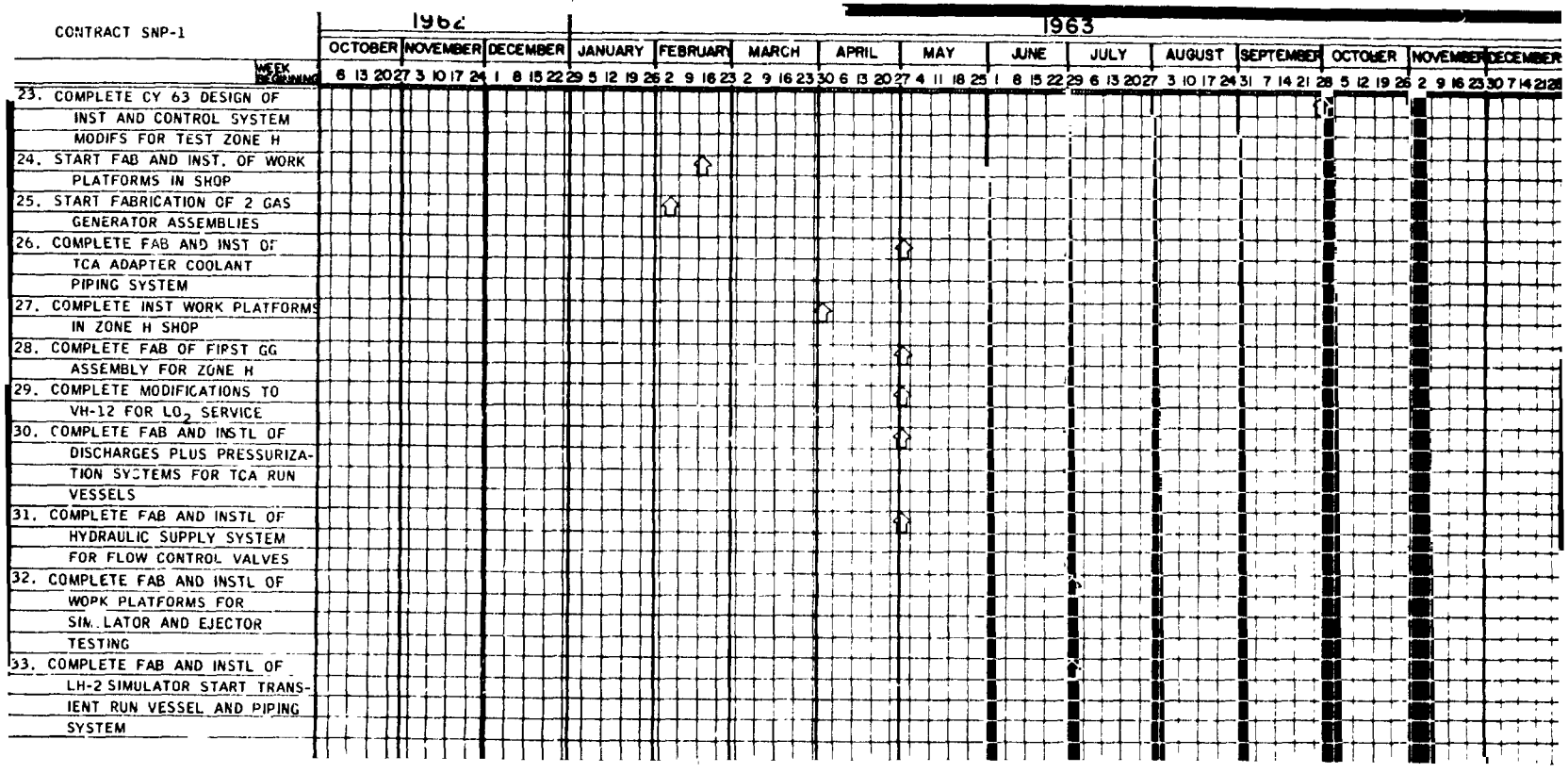
◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

Figure 1
Sheet 45 of 54

REON

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 5.3
DESIGN AND CONSTRUCTION MANAGEMENT


CONTRACT SNP-1
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
23. COMPLETE CY 63 DESIGN OF INST AND CONTROL SYSTEM MODIFS FOR TEST ZONE H
24. START FAB AND INST. OF WORK PLATFORMS IN SHOP
25. START FABRICATION OF 2 GAS GENERATOR ASSEMBLIES
26. COMPLETE FAB AND INST OF TCA ADAPTER COOLANT PIPING SYSTEM
27. COMPLETE INST WORK PLATFORMS IN ZONE H SHOP
28. COMPLETE FAB OF FIRST GG ASSEMBLY FOR ZONE H
29. COMPLETE MODIFICATIONS TO VH-12 FOR LO_2 SERVICE
30. COMPLETE FAB AND INSTL OF DISCHARGES PLUS PRESSURIZATION SYSTEMS FOR TCA RUN VESSELS
31. COMPLETE FAB AND INSTL OF HYDRAULIC SUPPLY SYSTEM FOR FLOW CONTROL VALVES
32. COMPLETE FAB AND INSTL OF WORK PLATFORMS FOR SIMULATOR AND EJECTOR TESTING
33. COMPLETE FAB AND INSTL OF LH-2 SIMULATOR START TRANSIENT RUN VESSEL AND PIPING SYSTEM

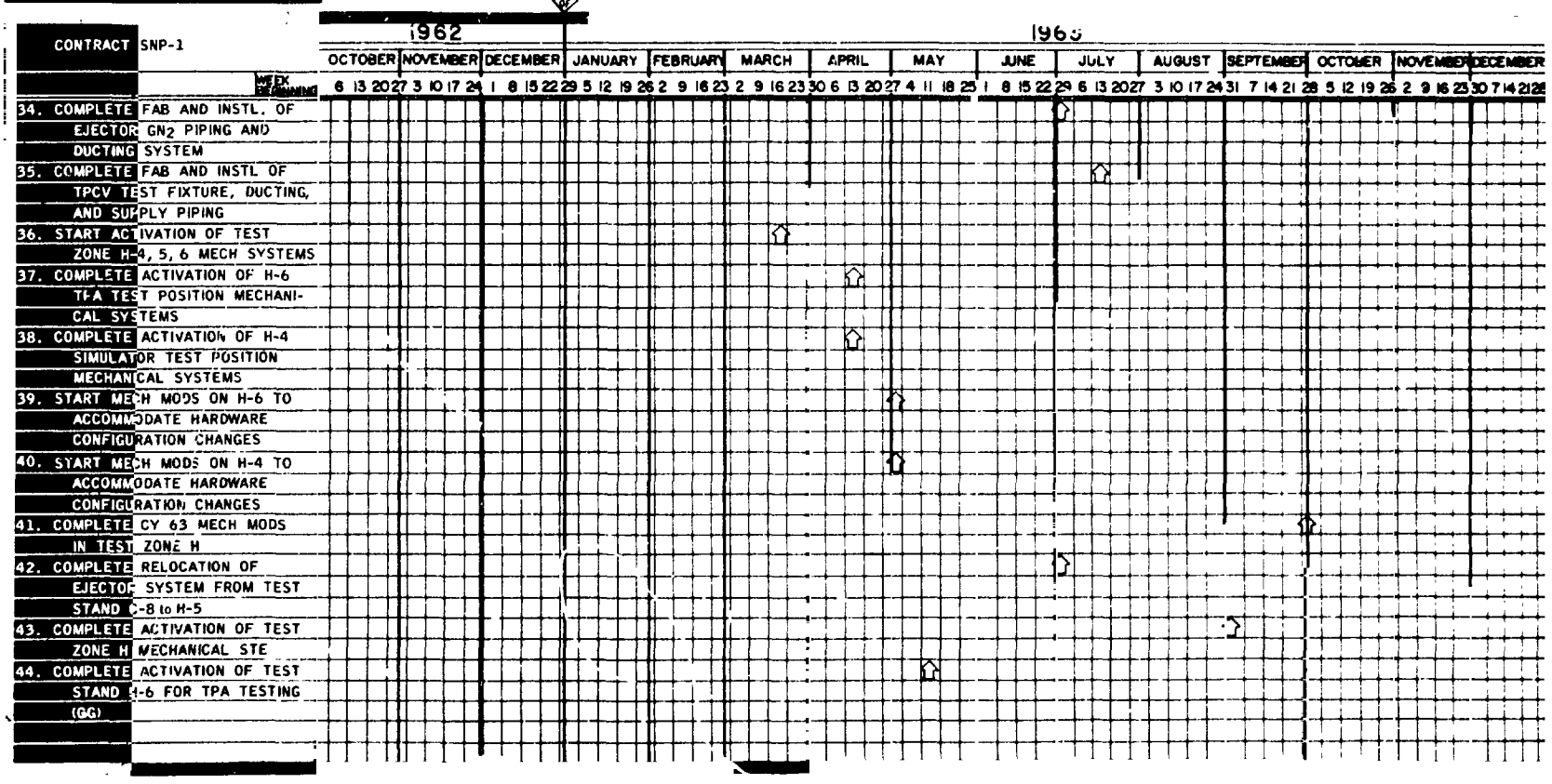
◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

Figure 1
Sheet 46 of 54

REON

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 5.3
DESIGN AND CONSTRUCTION MANAGEMENT


CONTRACT SNP-1
WEEK BEGINNING
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
34. COMPLETE FAB AND INSTL. OF
EJECTOR GN_2 PIPING AND
DUCTING SYSTEM
35. COMPLETE FAB AND INSTL OF
TPCV TEST FIXTURE, DUCTING,
AND SUPPLY PIPING
36. START ACTIVATION OF TEST
ZONE H-4, 5, 6 MECH SYSTEMS
37. COMPLETE ACTIVATION OF H-6
TPA TEST POSITION MECHANI-
CAL SYSTEMS
38. COMPLETE ACTIVATION OF H-4
SIMULATOR TEST POSITION
MECHANICAL SYSTEMS
39. START MECH MODS ON H-6 TO
ACCOMMODATE HARDWARE
CONFIGURATION CHANGES
40. START MECH MODS ON H-4 TO
ACCOMMODATE HARDWARE
CONFIGURATION CHANGES
41. COMPLETE CY 63 MECH MODS
IN TEST ZONE H
42. COMPLETE RELOCATION OF
EJECTOR SYSTEM FROM TEST
STAND C-8 to H-5
43. COMPLETE ACTIVATION OF TEST
ZONE H MECHANICAL STE
44. COMPLETE ACTIVATION OF TEST
STAND H-6 FOR TPA TESTING
(GG)

◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

Figure 1
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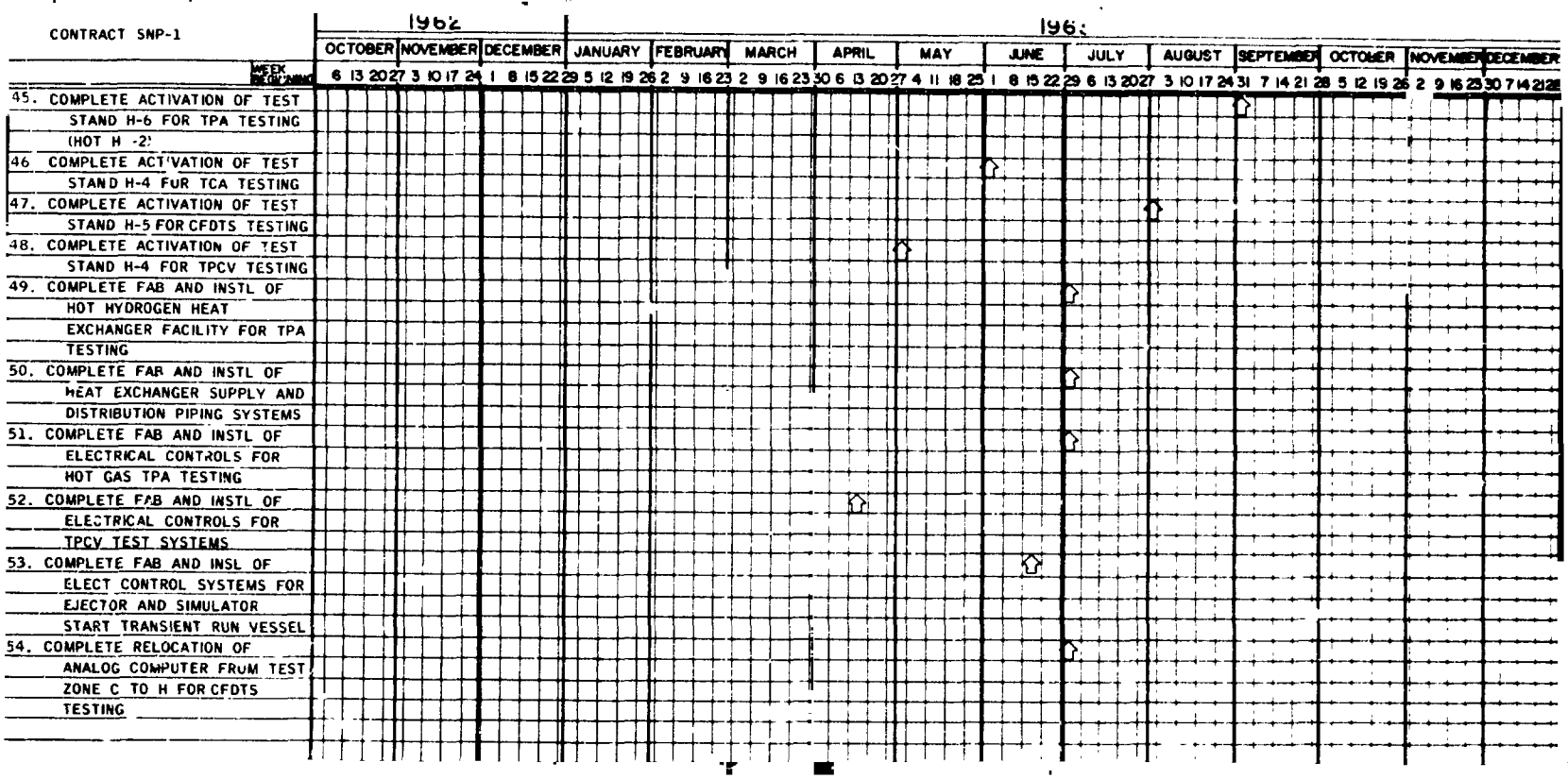
REON

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 5.3
DESIGN AND CONSTRUCTION MANAGEMENT

CONTRACT SNP-1


1962
1963
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
45. COMPLETE ACTIVATION OF TEST STAND H-6 FOR TPA TESTING (HOT H -2)
46 COMPLETE ACTIVATION OF TEST STAND H-4 FOR TCA TESTING
47. COMPLETE ACTIVATION OF TEST STAND H-5 FOR CFDTS TESTING
48. COMPLETE ACTIVATION OF TEST STAND H-4 FOR TPCV TESTING
49. COMPLETE FAB AND INSTL OF HOT HYDROGEN HEAT EXCHANGER FACILITY FOR TPA TESTING
50. COMPLETE FAB AND INSTL OF HEAT EXCHANGER SUPPLY AND DISTRIBUTION PIPING SYSTEMS
51. COMPLETE FAB AND INSTL OF ELECTRICAL CONTROLS FOR HOT GAS TPA TESTING
52. COMPLETE FAB AND INSTL OF ELECTRICAL CONTROLS FOR TPCV TEST SYSTEMS
53. COMPLETE FAB AND INSL OF ELECT CONTROL SYSTEMS FOR EJECTOR AND SIMULATOR START TRANSIENT RUN VESSEL
54. COMPLETE RELOCATION OF ANALOG COMPUTER FROM TEST ZONE C TO H FOR CFDTS TESTING

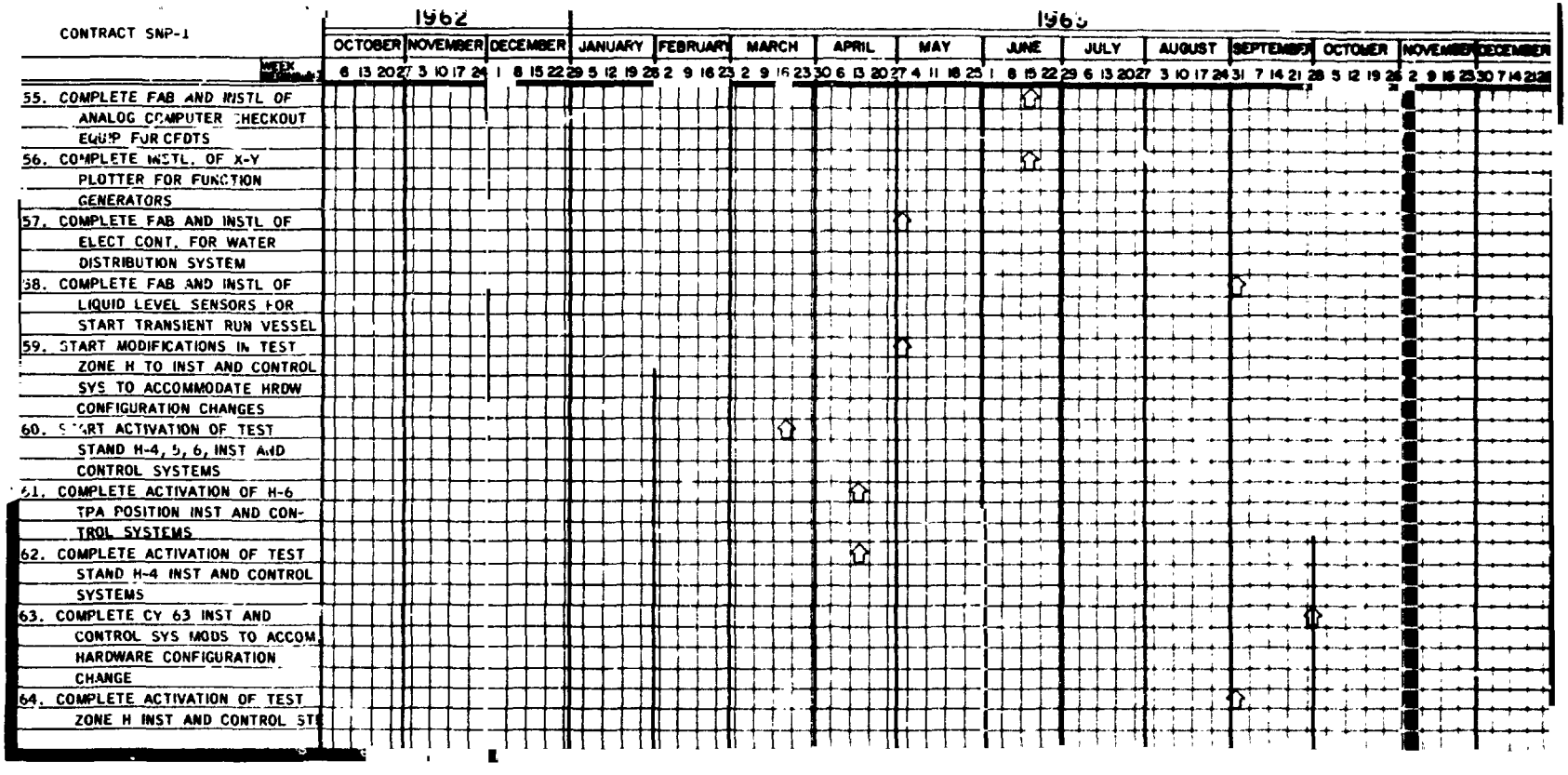
◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

Figure 1
Sheet 48 of 54

REON

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 5.3
DESIGN AND CONSTRUCTION MANAGEMENT


CONTRACT SNP-1
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK
55. COMPLETE FAB AND INSTL OF ANALOG COMPUTER CHECKOUT EQUIP FOR CFDTS
56. COMPLETE INSTL. OF X-Y PLOTTER FOR FUNCTION GENERATORS
57. COMPLETE FAB AND INSTL OF ELECT CONT. FOR WATER DISTRIBUTION SYSTEM
58. COMPLETE FAB AND INSTL OF LIQUID LEVEL SENSORS FOR START TRANSIENT RUN VESSEL
59. START MODIFICATIONS IN TEST ZONE H TO INST AND CONTROL SYS TO ACCOMMODATE HRDW CONFIGURATION CHANGES
60. START ACTIVATION OF TEST STAND H-4, 5, 6, INST AND CONTROL SYSTEMS
61. COMPLETE ACTIVATION OF H-6 TPA POSITION INST AND CONTROL SYSTEMS
62. COMPLETE ACTIVATION OF TEST STAND H-4 INST AND CONTROL SYSTEMS
63. COMPLETE CY 63 INST AND CONTROL SYS MODS TO ACCOM. HARDWARE CONFIGURATION CHANGE
64. COMPLETE ACTIVATION OF TEST ZONE H INST AND CONTROL ST

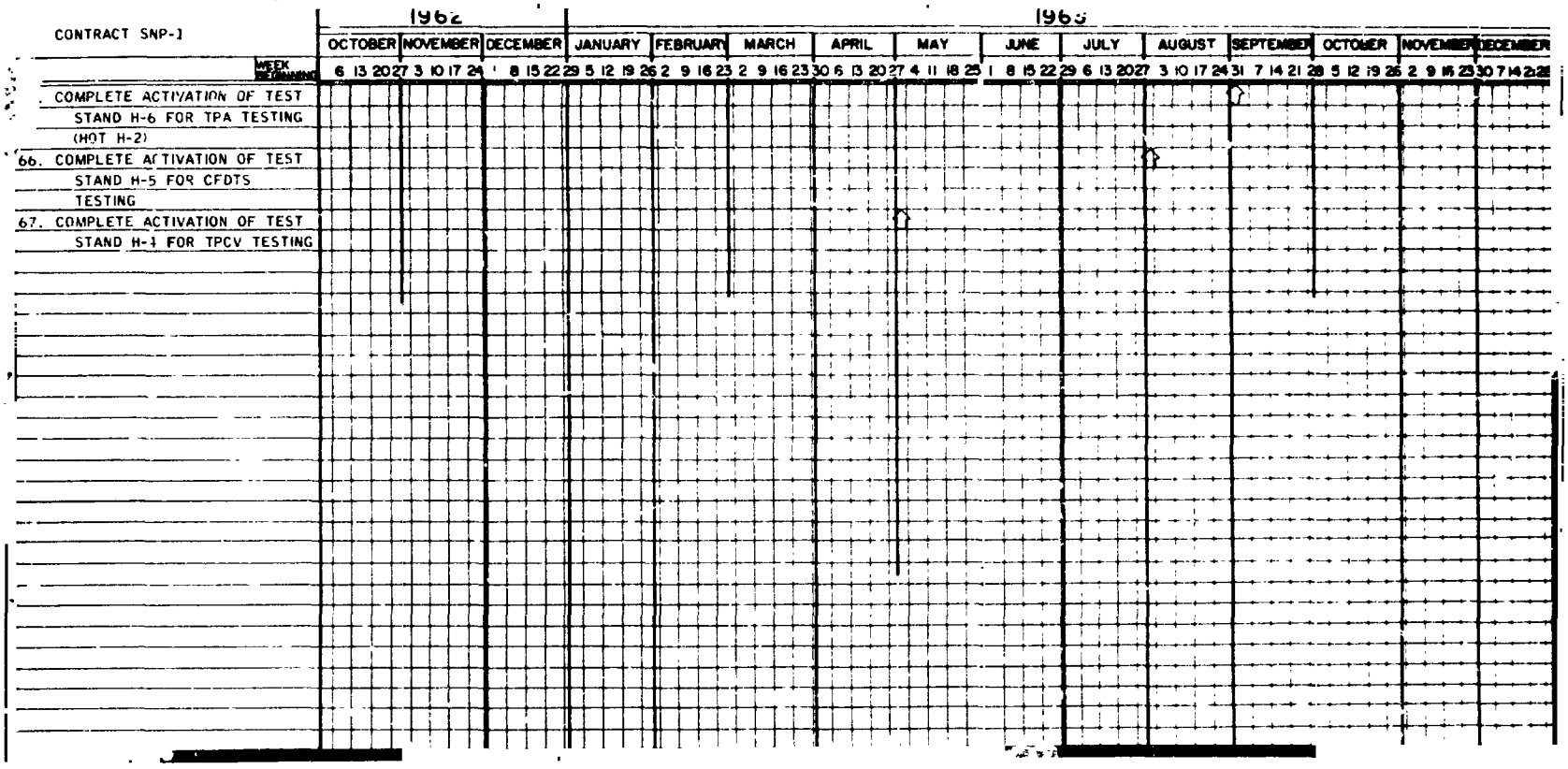
◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 49 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 5.3
DESIGN AND CONSTRUCTION MANAGEMENT


CONTRACT SNP-1
1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
. COMPLETE ACTIVATION OF TEST STAND H-6 FOR TPA TESTING (HOT H-2)
66. COMPLETE ACTIVATION OF TEST STAND H-5 FOR CFDTS TESTING
67. COMPLETE ACTIVATION OF TEST STAND H-1 FOR TPCV TESTING

◇ SCHEDULED MILESTONE
◇ RESCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◆ RESCHEDULED MILESTONE ACHIEVEMENT

Figure 1
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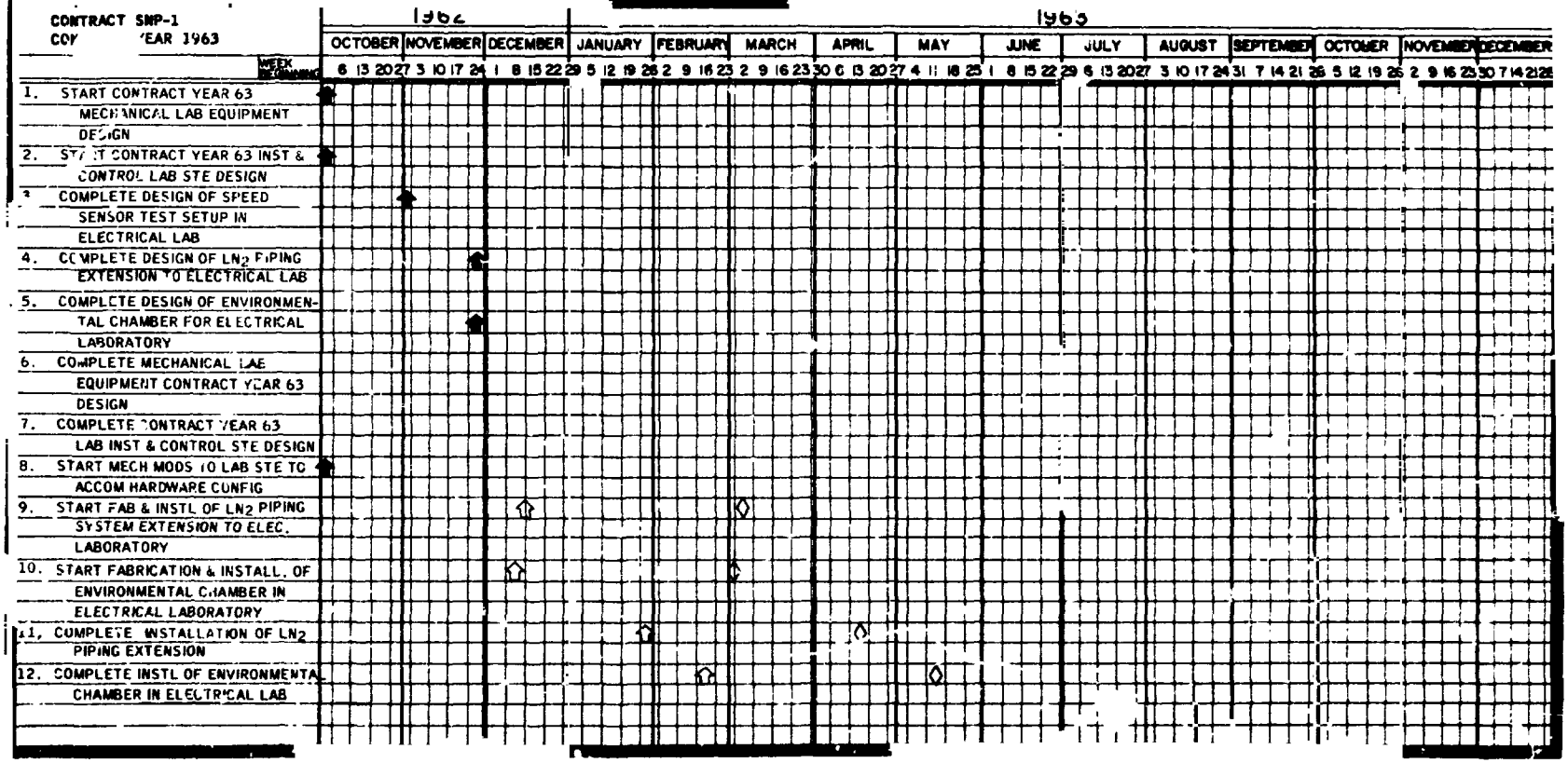
REON

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 5.9
STE-AGC (LRP LABORATORY FACILITIES)

CONTRACT SNP-1
COY 'EAR 1963


1962
1963
OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER
WEEK BEGINNING
6 13 20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 2 9 16 23 2 9 16 23 30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2 9 16 23 30 7 14 21 28
1. START CONTRACT YEAR 63 MECHANICAL LAB EQUIPMENT DESIGN
2. START CONTRACT YEAR 63 INST & CONTROL LAB STE DESIGN
3. COMPLETE DESIGN OF SPEED SENSOR TEST SETUP IN ELECTRICAL LAB
4. COMPLETE DESIGN OF LN2 PIPING EXTENSION TO ELECTRICAL LAB
5. COMPLETE DESIGN OF ENVIRONMENTAL CHAMBER FOR ELECTRICAL LABORATORY
6. COMPLETE MECHANICAL LAB EQUIPMENT CONTRACT YEAR 63 DESIGN
7. COMPLETE CONTRACT YEAR 63 LAB INST & CONTROL STE DESIGN
8. START MECH MODS TO LAB STE TO ACCOM HARDWARE CONFIG
9. START FAB & INSTL OF LN2 PIPING SYSTEM EXTENSION TO ELEC. LABORATORY
10. START FABRICATION & INSTALL. OF ENVIRONMENTAL CHAMBER IN ELECTRICAL LABORATORY
11. COMPLETE INSTALLATION OF LN2 PIPING EXTENSION
12. COMPLETE INSTL OF ENVIRONMENTAL CHAMBER IN ELECTRICAL LAB

◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

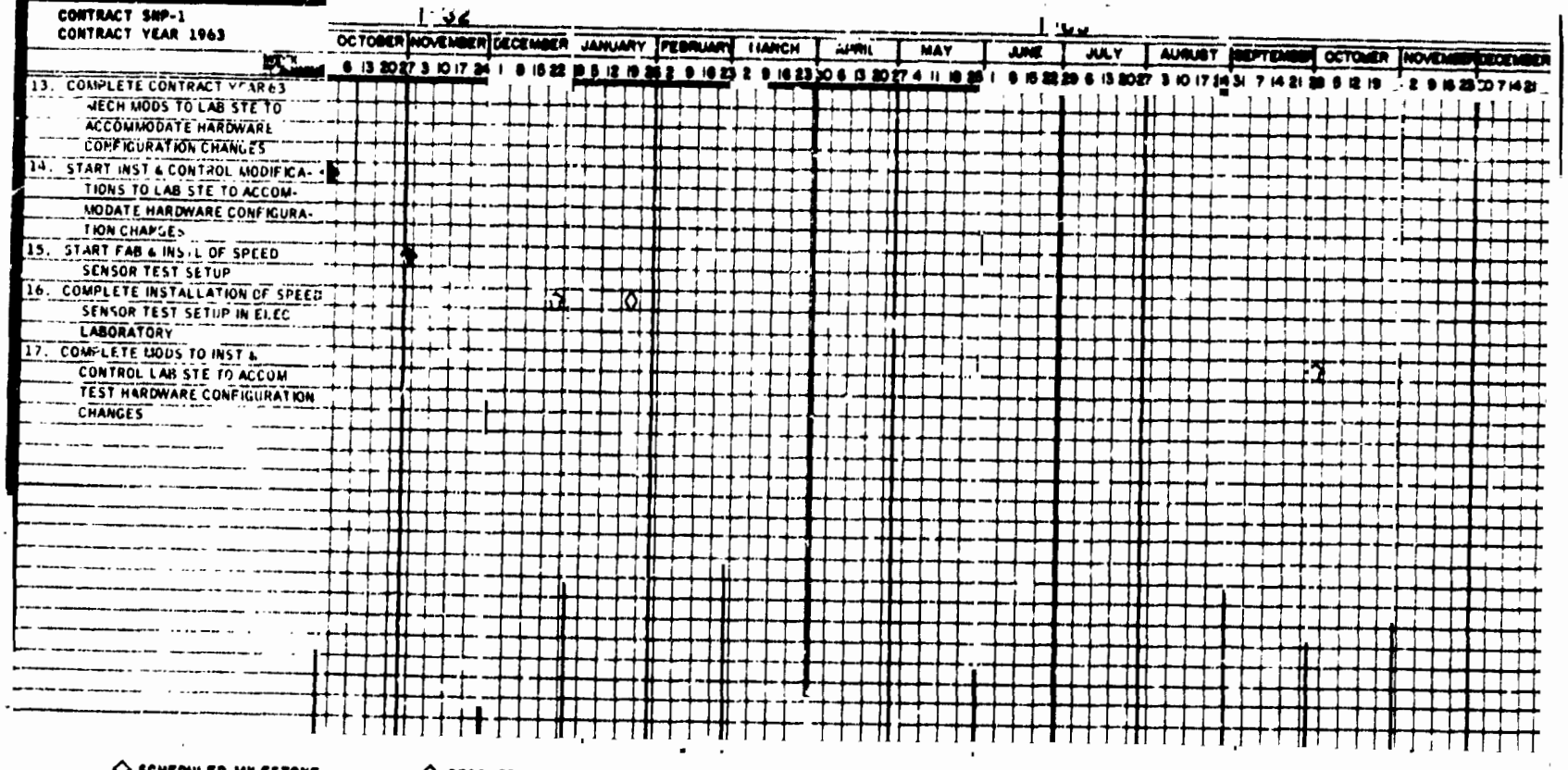
REON

Figure 1
Sheet 51 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT AR 1963
TASK ITEM 5.9
STE-ACC (LRP LABORATORY FACILITIES) (CONT'D)

CONTRACT SNP-1
CONTRACT YEAR 1963


OCTOBER
NOVEMBER
DECEMBER
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MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
13. COMPLETE CONTRACT YEAR 63 MECH MODS TO LAB STE TO ACCOMMODATE HARDWARE CONFIGURATION CHANGES
14. START INST & CONTROL MODIFICATIONS TO LAB STE TO ACCOMMODATE HARDWARE CONFIGURATION CHANGES
15. START FAB & INSTL OF SPEED SENSOR TEST SETUP
16. COMPLETE INSTALLATION OF SPEED SENSOR TEST SETUP IN ELEC LABORATORY
17. COMPLETE MODS TO INST & CONTROL LAB STE TO ACCOM TEST HARDWARE CONFIGURATION CHANGES

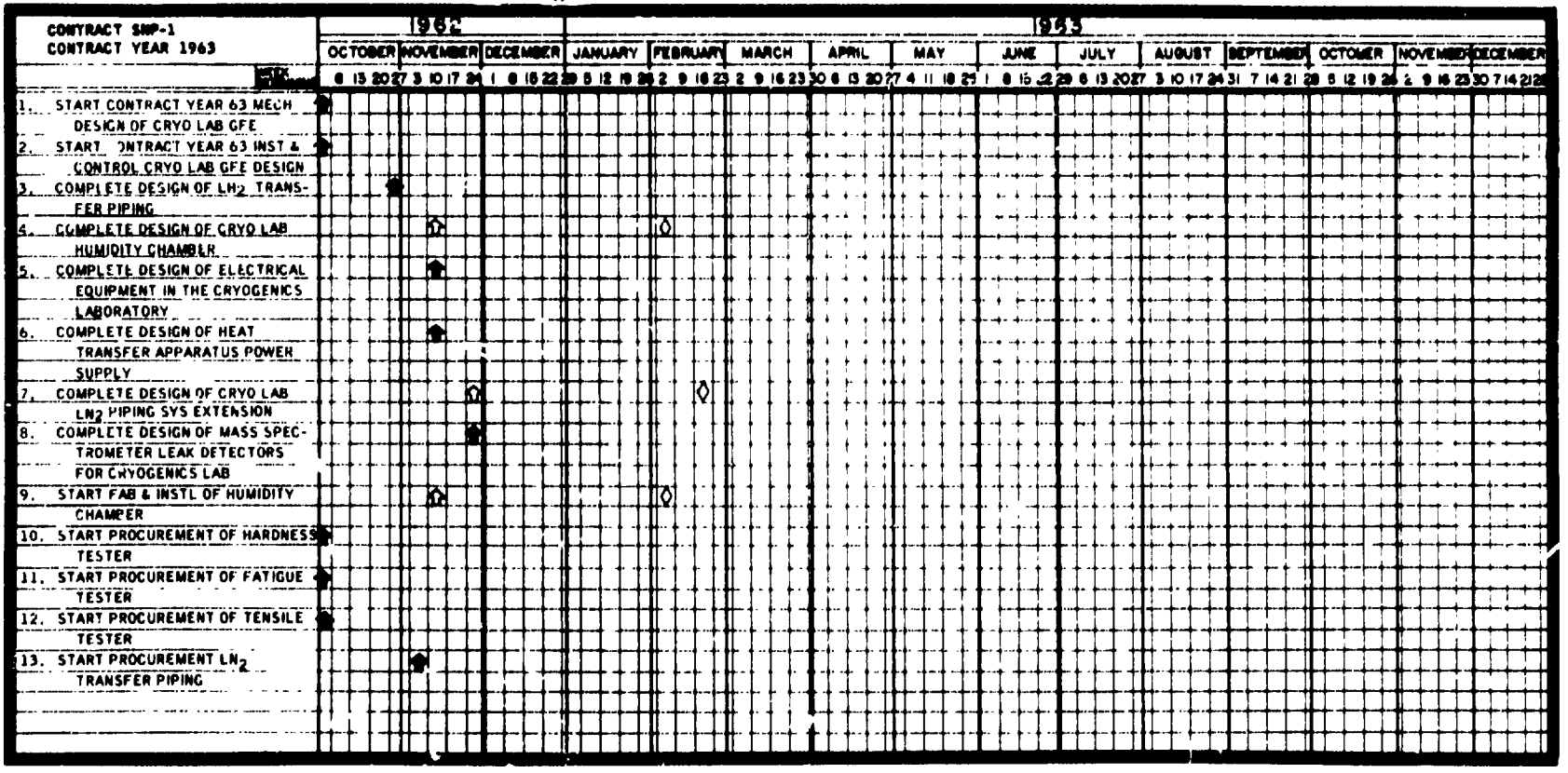
◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 52 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 6.2
GOVERNMENT PROPERTY - AGC (LRC TEST ZONE "A")


CONTRACT SNP-1
CONTRACT YEAR 1963
1962
1963
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
1. START CONTRACT YEAR 63 MECH DESIGN OF CRYO LAB GFE
2. START CONTRACT YEAR 63 INST & CONTROL CRYO LAB GFE DESIGN
3. COMPLETE DESIGN OF LH_2 TRANSFER PIPING
4. COMPLETE DESIGN OF CRYO LAB HUMIDITY CHAMBER
5. COMPLETE DESIGN OF ELECTRICAL EQUIPMENT IN THE CRYOGENICS LABORATORY
6. COMPLETE DESIGN OF HEAT TRANSFER APPARATUS POWER SUPPLY
7. COMPLETE DESIGN OF CRYO LAB LN_2 PIPING SYS EXTENSION
8. COMPLETE DESIGN OF MASS SPECTROMETER LEAK DETECTORS FOR CRYOGENICS LAB
9. START FAB & INSTL OF HUMIDITY CHAMPER
10. START PROCUREMENT OF HARDNESS TESTER
11. START PROCUREMENT OF FATIGUE TESTER
12. START PROCUREMENT OF TENSILE TESTER
13. START PROCUREMENT LN_2 TRANSFER PIPING

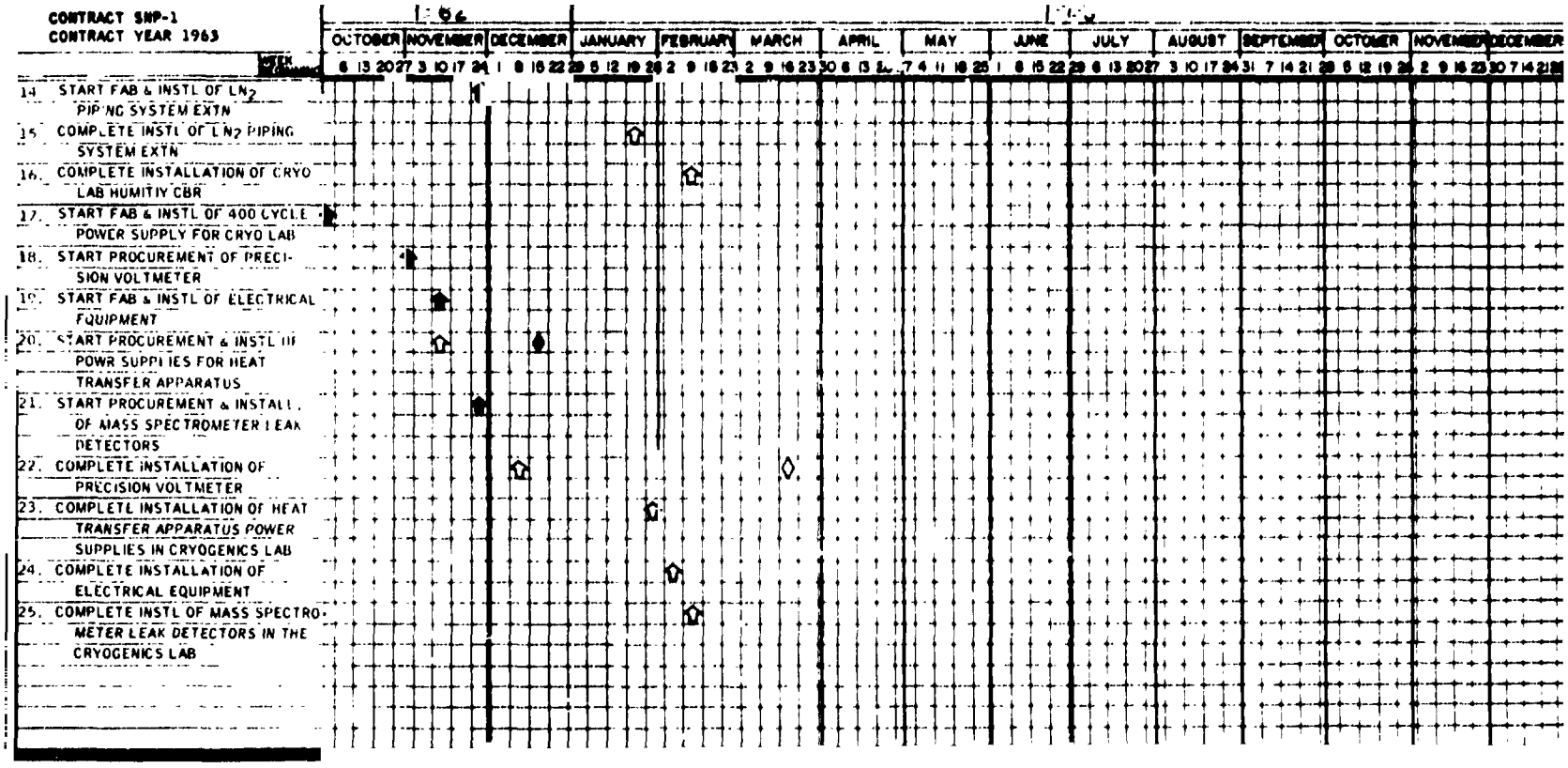
◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
Sheet 53 of 54

NERVA PROGRAM

SCHEDULES AND MILESTONES
CONTRACT YEAR 1963
TASK ITEM 6.2
GOVERNMENT PROPERTY - AGC (LRP TEST ZONE "A") (CONT'D)


CONTRACT SNP-1
CONTRACT YEAR 1963
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
14. START FAB & INSTL OF LN2 PIPING SYSTEM EXTN
15. COMPLETE INSTL OF LN2 PIPING SYSTEM EXTN
16. COMPLETE INSTALLATION OF CRYO LAB HUMITIY CBR
17. START FAB & INSTL OF 400 CYCLE POWER SUPPLY FOR CRYO LAB
18. START PROCUREMENT OF PRECISION VOLTMETER
19. START FAB & INSTL OF ELECTRICAL EQUIPMENT
20. START PROCUREMENT & INSTL OF POWR SUPPLIES FOR HEAT TRANSFER APPARATUS
21. START PROCUREMENT & INSTALL OF MASS SPECTROMETER LEAK DETECTORS
22. COMPLETE INSTALLATION OF PRECISION VOLTMETER
23. COMPLETE INSTALLATION OF HEAT TRANSFER APPARATUS POWER SUPPLIES IN CRYOGENICS LAB
24. COMPLETE INSTALLATION OF ELECTRICAL EQUIPMENT
25. COMPLETE INSTL OF MASS SPECTROMETER LEAK DETECTORS IN THE CRYOGENICS LAB

◇ SCHEDULED MILESTONE
◆ MILESTONE ACHIEVEMENT
◇ RESCHEDULED MILESTONE
◆ RESCHEDULED MILESTONE ACHIEVEMENT

REON

Figure 1
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